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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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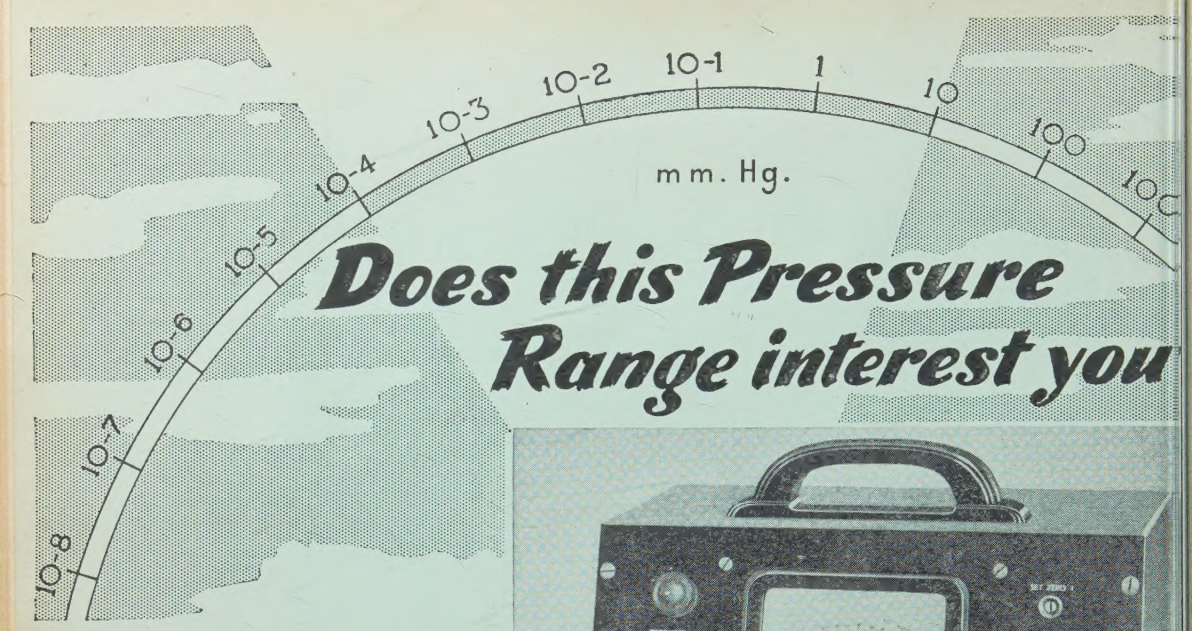
VOLUME 54 **NOVEMBER 1951** NUMBER 647



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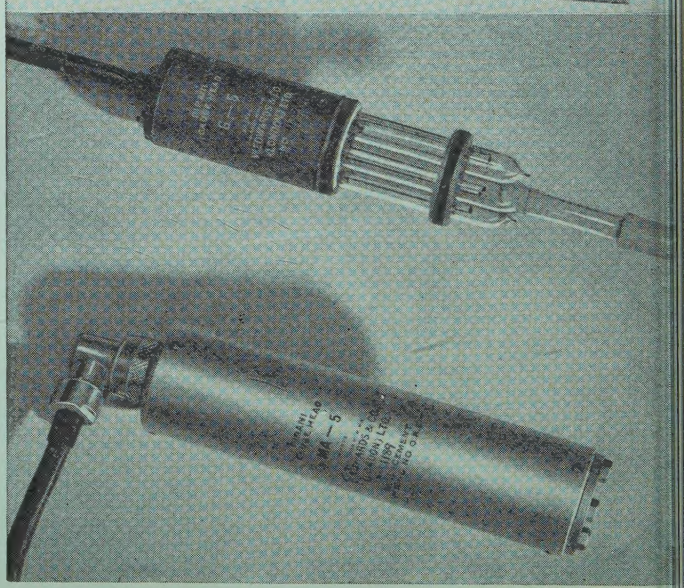

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Mechanical testing
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Industrial radiography
Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplement published with the Index to Volume 53 (1950). Reprints of the List of Journals (1950) and the Supplement (1950) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

Beretn. Michelsens Inst. Videnskap.	*Beretninger Chr. Michelsens Institutt for Videnskap og Åndsfrihet.* Allégaten 70, Bergen.
Bull. Soc. Franc. Minér. Crist.	*Bulletin de la Société Française de Minéralogie et de Cristallographie.* Librairie Masson et Cie, 120 Boulevard Saint-Germain, Paris.
Matrix Tensor Quart.	*Matrix and Tensor Quarterly.* The Tensor Club of Great Britain. C/o S. A. Stigant, Esq., M.I.E.E., 7 Courtlands Avenue, Hayes, Kent.
**Riv. Met. Aeronaut.*	*Rivista di Meteorologia Aeronautica.* [Abstracted by *Meteorological Abstracts.*]
**Trudy Sem. Vektor. Tenzor. Analizu.*	*Trudy Seminara po Ventornomu i Tenzornomu Analizu s Ih Priloženiyami k Geometrii, Mehaniki i Fiziki.* [Abstracted by *Mathematical Reviews.*]

New Journals

Acustica	*Acustica.* S. Hirzel Verlag, Claridenhof, Gotthardstrasse 6, Zürich 2. Vol. 1 (No. 1) dated 1951. To be issued in 6 numbers per annum of approximately 48 pages each. Subscription rate: 36 Swiss francs per volume. [See also *Akustische Beihefte.*]
Akust. Beih.	*Akustische Beihefte.* S. Hirzel Verlag, Claridenhof, Gotthardstrasse 6, Zürich 2. Issued under the auspices of the international acoustics journal *Acustica* as a Supplement. Issues do not appear regularly and are included in the subscription price. No. 1 dated 1951.
Izv. Bylg. Akad. Nauk	*Izvestiya Bylgarskata Akademia na Naukite. Otdelenie za Fizikomatematicheski i Tekhnicheski Nauki.* Rue 7 Noemvri, Sofia 1. Vol. 1 dated 1950, received *September* (1951). Subscription 600 leva.
J. Sci. Res. Benares Hindu Univ.	*Journal of Scientific Research of the Benares Hindu University.* P.O.—Benares Hindu University, India. Vol. 1 dated 1950–51, published *July* (1951).

Notes

Elektron, Garmisch	This designation will now be used for the journal formerly referenced as *Elektron* to distinguish it from the journal *Elektron, Linz.*
Siemens Austria Tech. Ber.	*Siemens Austria Technische Berichte.* Change of title—formerly *Siemens Austria Zeitschrift.*

Original Articles

It is regretted that the articles from which abstracts are made cannot be supplied on loan, nor can copies or microfilms of them be supplied. Application should be made to appropriate lending libraries, or to the publishers of the journals concerned; publishers' addresses, wherever known, are given in the List of Journals. Assistance will be gladly given in cases of particular difficulty.

It should be emphasized that an abstract is only published in *Science Abstracts* when an article or book is believed to be generally available. No abstracts are published of dissertations, reports, or memoranda with limited circulation, unless copies have been deposited with several public libraries; nor of papers presented orally at meetings, unless précis of substantial length are published in the normal way.

Thus the appearance of an abstract in *Science Abstracts* may generally be taken as an indication that the original is publicly available, and information for its identification and acquisition, if not given in the abstract, will be found elsewhere in *Science Abstracts*.

Errata

Author Index (1950), p. 1069, column 1; BLEKSLEY, A. E. H.: *for* 7961 *read* 7691.

Abstr. 2595 (1951), line 2: *for* J. V. RAMSEY *read* J. V. RAMSAY.

Abstr. 5510 (1951), line 2: *for* K. B. TOLPIGO *read* K. B. TOLPYGO.

Abstr. 6741 (1951,) line 2: *for* M. V. S. VRKLJAN *read* V. S. VRKLJAN.

Abstr. 7733 (1951), line 3: *for* (1951) *read* (1950).

SCIENCE ABSTRACTS

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MATHEMATICS 51

513.771 : 548.12

8420. Homology space groups. V. I. MIKHEEV. *Dokl. Akad. Nauk, SSSR*, 77 (*No.* 5) 807–10 (1951) *In Russian.*

An illustration is given of the way in which homology space groups can be built up by combining homology point groups with translations. A plane of homology has a direction t associated with it and operates on a point A to give another point A′ which lies in the direction t from A at such a distance that the plane of homology passes through the mid-point of AA′. It is shown that when a plane of homology Π is combined with a translation T parallel to t a new plane of homology Π' appears, related to the first by a translation $\frac{1}{2}T$, and that when T is not parallel to t a homology glide-plane appears instead of Π'. A. L. MACKAY

517.5

8421. Non-hermitian operators and eigenfunction expansions. G. IWATA. *Progr. Theor. Phys.*, **6**, 216–26 (*March–April*, 1951).

For the present only Hermitian operators play the chief role in the theoretical physics. The importance of non-Hermitian operators is discussed. Annihilation or creation operators are clearly non-Hermitian. Eigenfunction expansions over some closed curve in the complex plane are also considered. A.

517.544.2

8422. On some estimates relating to the Green function. S. G. MIKHLIN. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 443–6 (1951) *In Russian.*

The following theorem is proved for a function u, being a solution of Poisson's equation and vanishing on the periphery of the circle of unit radius. This function must satisfy the inequality

$$\iint_{R<1} \left| \frac{\partial^2 u}{\partial x_k \partial x_m} \right|^2 dx_1 dx_2 \leqslant C^2 \iint_{R<1} |g(x_1,x_2)|^2 dx_1 dx_2$$

where $g(x_1,x_2)$ is the disturbing function of Poisson's equation (or the kernel of the Green function of the problem), C a constant. The proof is based on an auxiliary theorem previously published by the author [*Dokl. Akad. Nauk, SSSR*, **15** (*No.* 8) (1937)]. B. F. KRAUS

517.6

8423. On the method of saddle points. B. L. VAN DER WAERDEN. *Appl. Sci. Res.*, **B2** (*No.* 1) 33–45 (1951).

If a complex integral is evaluated by the method of saddle points, a difficulty arises as soon as a pole lies near a saddle point. In this paper the saddle-point method is developed in such a form that the part of the integral corresponding to the pole can be split off immediately. In addition to the usual terms an incomplete gamma function is found. A.

517.63

8424. The calculation of the coefficients of certain asymptotic series by means of linear recurrent relations. H. A. LAUWERIER. *Appl. Sci. Res.*, **B2** (*No.* 2) 77–84 (1951).

518.3 : 514.6 : 621.396.11

8425. Nomogram and slide-rule for solution of spherical triangle problems found in radio communication. D. V. DICKSON. *J. Geophys. Res.*, **56**, 163–75 (*June*, 1951).

518.5

8426. An apparatus using a Renard series. J. ALLAIS. *C.R. Acad. Sci., Paris*, **232**, 1997–9 (*May* 28, 1951) *In French.*

Description of a film slide-rule having discrete positions. The use of a disk with apertures as a cursor, enables the table to be arranged compactly on the film. The table used is a Renard–Androuin sequence, terms in geometric progression with common ratio $n\sqrt{10}$, used for standardizing dimensions in designs. The device automatically locates the decimal point. $A \times B \div C$ can be found in 10 sec. S. MICHAELSON

518.5 : 522.6

8427. Punched card machines at Herstmonceux. J. G. PORTER. *J. Brit. Astron. Ass.*, **61**, 185–9 (*July*, 1951).

A very brief outline of the main operations and uses of the standard machines employed which include the new I.B.M. calculating punch 602A. A. J. KENNEDY

518.5 : 681.142 : 621.318.572

8428. Project for an electronic (digital) computer. A. SPEISER. *Diss. E.T.H. Zürich, No.* 1933, 54 *pp.* (1951) *In German.*

The equipment contains 1 000 valves and 300 relays and works with 12-place decimal numbers. These numbers are coded by Aiken's method using four binary digits. The store consists of several magnetic drums 51 cm dia. and 35 cm long rotating at 3 600 r.p.m. The storage capacity is 1 200 words where a word is either a 12-place number or two commands. The mean search time is 16 msec. The fundamental number-time is 400 μsec, addition takes 0·8 msec, multiplication about 30 msec and division about 40 msec. Commands consist of an operation-code and an address. Access to the input or output of the machine is by commercial teletype apparatus. Input is by means of perforated tape and output is available either in the form of punched tape or direct printing. The special requirements of this equipment were cheapness and economy of material. For this, series operation is adopted and relays are used where the corresponding valve circuit would be more complicated. For example, the connection between the store and the registers is by means of a "pyramid" of relays. The fact that each command contains only one address and that both commands and numbers are stored together means that there is only one pyramid in the entire machine. Storage and

reading are carried out by the one magnetic head per drum since these operations are not required simultaneously. Provision is made for carrying out operations at doubled accuracy (24-place numbers). Each part of the equipment is described in detail and examples are given of particular calculations.

S. C. DUNN (R)

519.2 : 621.391

8429. The adaptation of a message to the transmission channel. I. Information quanta. II. Physical interpretations. B. MANDELBROT. *C.R. Acad. Sci., Paris*, **232**, 1638–40 (*April* 30); 2003–5 (*May* 28, 1951) *In French.*

A mathematical development on the basis laid by Shannon [Abstr. 2844 B (1949) *Bell Syst. Tech. J.*, **27**, 379–423 (*July*); 623–56 (*Oct.*, 1948)], with account taken of ordinal coding, providing statistical expressions for such adaptation from the points of view of entropy and structure. Part II develops from a concept of chain processes composed of elements of differentiation (experience, increase in entropy, separation of mixed elements) and integration (the inverse), and applies these to the properties and the study of physical systems.

A. J. KENNEDY

519.24

8430. Theoretical backgrounds of the statistical methods. H. SCHEFFÉ. *Industr. Engng Chem.*, **43**, 1292–4 (*June*, 1951).

An outline of basic concepts without introducing detailed mathematics. A.

519.24

8431. Theoretical backgrounds of the statistical methods. F. MOSTELLER. *Industr. Engng Chem.*, **43**, 1295–7 (*June*, 1951).

A discussion of the notion of testing hypotheses, including such concepts as null hypothesis, significance level, power and regression. A.

519.24

8432. Design of experiments for most precise slope estimation. C. DANIEL. *Industr. Engng Chem.*, **43**, 1298–300 (*June*, 1951).

The well-known methods for calculating the variance of the slope of a least-square fitted straight line are given briefly, both for constant precision of y measurements and for variable though known precision. When the relation between two variables is known to be linear, proper choice of x values at which y is to be measured can greatly increase the precision with which the slope is estimated. The gain, compared to the usual N equally spaced points, may be from one third to two thirds of N for a given precision of the slope estimate. A.

519.24 : 541.182.2/.3

Fitting bimodel particle size distribution curves. *See Abstr.* 9079

519.24 : 621.395

8433. An outline of the principles of design and analysis of experiments. D. L. RICHARDS. *P.O. Elect. Engrs' J.*, **44**, 55–60 (*July*, 1951).

A general description of the more elementary parts of the subject, mainly in terms of problems arising in telephone research, N. L. JOHNSON

519.24 : 621.317.35

8434. Time and frequency uncertainty in waveform analysis. P. M. WOODWARD. *Phil. Mag.*, **42**, 883–91 (*Aug.*, 1951).

The concept of a structural time-constant is introduced by considering the time auto-correlation function of any waveform, and a structural frequency-constant is similarly defined in terms of the spectral auto-correlation function. By setting up a combined time and frequency auto-correlation function χ, an absolute time-frequency constant is obtained. Its value is always unity, and it is suggested that this expresses time and frequency uncertainty more precisely than the relation $\delta t \,.\, \delta f \geqslant 1/4\,\pi$. To illustrate the function χ, two special waveforms are considered, namely, the complex Gaussian pulse and the real Gaussian pulse-train. A.

519.25

8435. The ideal method for the determination of a physical characteristic is the analysis of an experimental curve. Examples. P. VERNOTTE. *C.R. Acad. Sci. Paris*, **233**, 230–2 (*July* 16, 1951) *In French.*

The quantity required often occurs as one of several parameters in some known relation. The relation corresponding to the most suitable experiment and involving the least number of parameters should be chosen. The range of variables such that the error in the experimental data has least effect on the desired quantity should be taken. The examples briefly discussed are the steady state method of determination of the thermal conductivity of a metal bar, the measurement of the focal length of an optical system and the determination of "g" from the observed fall of a body *in vacuo*. S. WEINTROUB

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.13

8436. Completely unstable systems of n gravitating bodies. G. F. KHILMI. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 3) 419–22 (1951) *In Russian.*

521.151 : 538.242

8437. On the gravitational field of magnetic moments. I. Z. FISHER. Letter in *J. Exp. Theor. Phys., USSR*, **20**, 956–7 (*Oct.*, 1950) *In Russian.*

The relation between mechanical and magnetic moments of heavenly bodies leads to an equivalence of the gravitational fields, due to a rotating, charge-free, non-magnetic mass and to the magnetic moment of a current. J. JACOBS

522.21

8438. Schmidt telescope studies. C. MORAIS. *Atti Fond. "Giorgio Ronchi,"* **6**, 137–53 (*June*, 1951) *In Italian.*

From the general expressions of the third-order

aberrations simple conditions are derived for their corrections in some particular cases of Schmidt telescope. A numerical example is given. The meridional curve of the aspherical surface of the plate is investigated as the locus of the centres of the circles, whose envelope is the wave-surface. The sine condition is satisfied by locating the plate in a suitable position. This is also illustrated by a numerical example. For a complete study of off-axis errors it would be necessary to consider higher-order aberrations, but this has not been done in the present paper. A.

522.615

8439. Counting of oscillations as a method of astronomical investigation. V. I. KRASOVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 427–9 (1951) *In Russian.*

It is proved that counting of oscillations, although not hitherto used as a method of astronomical investigation, is quite practicable and, indeed, a very simple and convenient method of observation. This refers to photographic observation with the use of electron-optical converter and secondary-electron amplifier with low-temperature cooling, which on principle permits of raising the sensitivity of the photographic method to the counting of single photons. Even with objectives < 1 m dia. the method offers the possibility of extending the radius of the known universe by more than one order of magnitude. B. F. KRAUS

522.615

8440. Recordings of scintillations. F. NETTELBLAD. Letter in *Observatory*, **71**, 111 (*June*, 1951).

The advantages of recording stellar scintillation photo-electrically with cathode-ray tube display are discussed. M. W. OVENDEN

522.615 : 523.53

8441. Photoelectric meteor observations. B. M. MCKINLEY AND D. W. R. MCKINLEY. *Canad. J. Phys.*, **29**, 11–21 (*March*, 1951).

The detector consists of 19 type 931A multiplier tubes covering the entire sky. Signals from the photocells are sequentially sampled in time and displayed on a c.r.t. P.e. meteor signals, radar echoes, and a marker operated by visual observers are photographed by a continuous-film camera. The average sensitivity of the detector to meteors was about one visual magnitude inferior to that of the eye. Approximate meteor positions and light intensities could be obtained from the record. Timing comparisons between the p.e. and radar records could be made to 0·05 sec. Methods of improving the sensitivity and operational characteristics are discussed. A. C. CLARKE

523.1

8442. A new approach to cosmology. III. A. E. H. BLEKSLEY. *S. Afr. J. Sci.*, **48**, 20–4 (*Aug.*, 1951).

For Pt II, see Abstr. 8435 (1950). A number of further results of cosmological importance are obtained: (i) the mass energy of the universe is equal to the negative potential energy due to gravitation, giving the constant of gravitation G in terms of the mass M and radius R of the universe, $G = R\,c^2/M$; (ii) the least (neutral) gravitating mass appears to be a meson; (iii) with any reasonable choice of units we find that the time systems defined by atomic and pendulum clocks must be essentially different; (iv) certain quantities usually regarded as constants of nature are found to be functions of the age of the universe; (v) it is possible to explain the observed reddening of the light of distant galaxies without assuming any physical recession of these bodies. A.

523.162

8443. Continuous absorption by interstellar matter. L. DIVAN. *C.R. Acad. Sci., Paris*, **233**, 284–5 (*July* 23, 1951) *In French.*

From a comparison of values of $\log(I'/I)_\lambda$ at different λ in the continuum of reddened, and non-reddened stars of similar type, e.g. ζ and ε Per: ζ Per and ρ Leo, it is shown that an accurate spectrophotometric study of interstellar absorption requires direct log. intensity comparisons with stars of identical spectral type. D. R. BARBER

523.165

8444. Radio-stars. I. S. SHKLOVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 3) 423–6 (1951) *In Russian.*

Analysing recently published data [mainly Ryle's, Abstr. 23 (1951)] on "point" sources of short wave radiation, the author suggests that "radio-stars" are about 30 times as numerous as "optical" stars in the region of the sun; less than 1/20th of the sun's mass; therefore probably of (optical) absolute magnitude fainter than 24; those so far observed not further than about 3 parsecs. Calling the "apparent radio-magnitude" of the point source in Cygnus 0·0 mag known radio-stars range from 3·4 mag to −0·6 mag, and the ratio of the number brighter than 3 mag to the number brighter than 2 mag is 4, against the theoretical 3·98 for uniform distribution in space. Radio-stars are probably of surface temperature 1 000–2 000°C of mass intermediate between the large planets and M9 type dwarfs. The probability of the existence of even more numerous, cooler, planet-like bodies, both in planetary systems and independently, is indicated. The desirability of efforts to photograph radio-stars in the infra-red is stressed. F. QUELON

523.165

8445. Observations of the source of radio-frequency radiation in the constellation of Cygnus. B. Y. MILLS AND A. B. THOMAS. *Aust. J. Sci. Res. A*, **4**, 158–71 (*June*, 1951).

The position and some of the properties of the source of radio-frequency radiation in Cygnus have been determined. The observed fluctuations in intensity have been found to correlate with activity in the F region of the ionosphere. There is no evidence that the emission from the source varies. A.

523.165 : 523.852

8446. The Crab-nebula as an observed point source of cosmic rays. Y. SEKIDO, T. MASUDA, S. YOSHIDA AND M. WADA. Letter in *Phys. Rev.*, **83**, 658 (*Aug.* 1, 1951).

The diurnal variation of high-energy cosmic rays, observed at depths of 1 200 meters water equivalent below the earth's surface, indicates an increase of about 10% in the intensity when the Crab nebula is contained within the solid angle of the receiver. No

measurable increase has been observed for any other of the point sources of radio noise. M. W. OVENDEN

523.165 : 523.72 : 523.852

8447. On the possibility of interpreting the radio "noise" of the sun and the galaxy as radiation from cosmic-ray protons in the intense magnetic fields of the sun and other celestial objects. B. KWAL. *Ann. Astrophys.*, **14** (*No.* 2) 189–98 (1951) *In French.*

A summary of the existing relations between the intensity of cosmic radiation and that of the solar and galactic radio emissions is followed by an examination of the different theories which have been proposed to explain the latter emissions. A study of the radiation of charged particles in magnetic fields of intensities similar to those found in celestial bodies suggests that cosmic-ray protons may emit radio radiation when in the neighbourhood of magnetic fields near "magnetic" stars or active regions of the sun. The simple application of this theory suggests an intensity per unit band width varying as $\nu^{-0.95}$ whereas experiment indicates a variation as $\nu^{-0.3}$; it is suggested that this discrepancy can be explained by (1) a variation of magnetic field at the region of origin, and (2) an energy distribution of cosmic-ray protons differing from that existing in the earth's upper atmosphere. M. W. OVENDEN

523.2

8448. Evolution of a system of gravitating bodies by non-elastic collisions. G. F. KHILMI. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 4) 589–92 (1951) *In Russian.*

The evolution theory considered is in the line of Kant's cosmogonic ideas and based on the conversion of mechanical into thermal energy in the pre-planetary stage by mass collisions of clods of star or meteorite dust. This problem was lately treated by O. Yu. Shmidt [Abstr. 1578 (1951)]. The author shows that, although the problem is obviously a many-body problem, a surprisingly simple mathematical apparatus allows of conclusive demonstration that dust clods must condense under repeated collisions (although the initial high speeds will in the first stage result in reducing the particle size) owing to permanent loss of kinetic and gain in potential energy. Thus not only are bigger and bigger particles formed, but the law of conservation of the moment of momentum cannot but ultimately result in rotation of the particles of steadily increasing size about one of their axes. The increase in size is limited by a maximum of the moment of inertia attainable. B. F. KRAUS

523.53

8449. Plasma oscillations in meteor trails. J. A. CLEGG AND R. L. CLOSS. Letter in *Proc. Phys. Soc., Lond. B*, **64**, 718–19 (*July*, 1951).

The relation between the intensity of a meteor echo and polarization with respect to the meteor path direction has been examined with twin directional aerials of perpendicular polarizations orientated with respect to the path direction of meteors of a given shower. Results confirm the prevalence of plasma oscillations in meteor trails. M. W. OVENDEN

523.72

8450. Reversal of polarisation of microwaves from sun-spots. U. C. GUHA. *Indian J. Phys.*, **25**, 8–16 (*Jan.*, 1951).

The Zwaan–Kemble method for the calculation of the reflection coefficient of a barrier has been used to obtain the reflection coefficients of the ordinary and the extraordinary waves for a parabolic ion barrier. These results have been applied to explain the observed reversal of polarization of microwaves escaping from sunspots. A.

523.72

8451. A study of the solar noise at 3 300 m.c. M. ODA AND T. TAKAKURA. Note in *J. Phys. Soc. Japan*, **6**, 202 (*May–June*, 1951).

The observed intensity and fluctuation of solar noise is consistent with the model of n statistically independent sources of average life-time 10 minutes and average intensity seen at the earth's surface of 10^{-26} W/cm/cycle/sec, where $n \simeq 1$ to $2\times$ the whole disk sunspot number. M. W. OVENDEN

523.72

8452. Solar radio-frequency emission from localized regions at very high temperatures. J. H. PIDDINGTON AND H. C. MINNETT. *Aust. J. Sci. Res. A*, **4**, 131–51 (*June*, 1951).

Solar radio-frequency radiation is analysed into three components; a basic steady component B, a slowly varying component S, and various forms of more or less rapid fluctuations X. The spectra of all three are drawn between 600 and 24 000 Mc/s, and suggested extensions to lower frequencies are discussed. The properties of S are described in some detail; these include correlation with sunspot data, polarization, and the location of the sources of origin. Evidence is presented in favour of generation by thermal processes. It is suggested that S is due to thermal emission from localized regions at temperatures of about 10^{7}°K, often in the vicinity of sunspots. The radiation from a model hot region is examined in detail and the emission spectrum and polarization characteristics are derived. The results are found to compare reasonably with observation. Thermionic emission of electrons and protons would probably occur from the hot regions. These particles would travel to the earth with average velocities of a few hundred km/sec and may be identical with the slow corpuscular radiation whose presence is deduced from terrestrial magnetic data. A.

523.72 : 551.521.1

Measurements of solar extreme ultraviolet and X-rays from rockets by means of a $CaSO_4$: Mn phosphor. *See Abstr.* 9209

523.746

8453. The prediction of Wolf numbers, and linear analysis. M. MAYOT. *Ann. Astrophys.*, **14** (*No.* 1) 232–5 (1951) *In French.*

Monthly and annual Wolf sunspot numbers may be predicted on the basis of linear recurrences obtained from past observational material. Similar results are obtained (to within $\pm 5\%$) from linear analyses of weighted monthly or annual mean numbers for 100-yr intervals. D. R. BARBER

523.75

8454. On the ascending motion of the eruptive prominence of the sun. II. M. NOTUKI. *Japan J. Astron.*, **1** (*No.* 1) 37–46 (1949).

Comparison of the observed accelerations of various

types of eruptive prominences with the deductions from Milne's theory. A. BEER

523.75

8455. On the cycle of the prominences. G. GODOLI. *Mem. Soc. Astron. Ital.*, **22** (*No.* 2) 137–46 (1951).

Results in better agreement with the present views on the dynamic relations of the various solar phenomena of the solar activity are obtained considering the 11 years cycle of the prominences without separating them into the two zones of high and low latitude. Comparing prominences and filaments it is possible to derive some difference in their behaviour. A.

523.752

8456. Ionization equilibrium in the solar chromosphere. Z. SUEMOTO. *Japan. J. Astron.*, **1** (*No.* 1) 7–16 (1949).

It is examined how far the theory of radiation equilibrium can account for the observed number of recombinations. A. BEER

523.755

8457. Continuous light of the solar corona. K. TAKAKUBO. *Publ. Astron. Soc. Japan*, **2** (*No.* 1) 14–22 (1950).

Polarization of the solar corona is recalculated with new information about the corona, and it is shown that the value of electron density of the corona and the gradient of its distribution fluctuate strongly with time and position. A distribution law of interplanetary particles for their sizes and distances is decided, but some assumptions are included. It is concluded that the distribution law holds only for particles whose radii are of the order of 10^{-3} cm. A provisional law of distribution for particles of all sizes is given. A.

523.755

8458. New method of investigating the solar corona. V. V. VITKEVICH. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 4) 585–8 (1951) *In Russian.*

The method suggested consists in systematic and coordinated observations of radio-brightness and temperature on several wavelengths in the dm and m band by interference methods with extended aerials at various bases. This should yield results concerning the altitude distribution of electron concentration and temperature in the corona. Interference observation from distributed bases with left and right polarized waves would be an appropriate active method of investigation of the magnetic field of the whole corona and the individual sections, whereas another, passive, method would be the observation of its translucence for "signals" from radio-stars. A theory of the last method is outlined. B. F. KRAUS

523.77

8459. On the reversal of absorption lines to the emissions at the extreme limb of the sun. A. HATTORI. *Publ. Astron. Soc. Japan*, **2** (*No.* 2) 66–73 (1950).

The transformation of the contours of absorption lines to the emissions at the flash time have been traced theoretically for Na *D*, Ca II *K* and weak lines. The change of the central intensity of strong Fraunhofer lines are discussed, taking into account the fluorescence or collision effect in the transfer equations. A.

523.77

8460. Spectrophotometry of chromospheric eruptions. E. R. MUSTEL AND A. B. SEVERNÍ. *Ann. Crimean Astrophys. Obs.*, **5** (1950); English Abstr. in *Astron. News Lett.* [*Harvard*] *No.* 56, 8–9 (*June* 20, 1951) *In Russian.*

The investigation is based on 12 standardized spectrograms of chromospheric eruptions. The characteristics of the contours of the Balmer series and the *H* and *K* lines are discussed; no asymmetry is found; a delay in the lifting of the wings of the *H* and *K* lines is interpreted as a result of ionization of Ca II in the reversing layer by the flare radiation, determined by the lines $L\beta$, $L\gamma$, etc., and radiation beyond the Lyman limit, the delay being due to the slow diffusion of high-frequency quanta from great optical depths. A similar effect for the hydrogen lines finds an analogous explanation. The height of the eruption is computed from the intensities of dark cores to the *H* and *K* lines. The observed contours have been carefully corrected for diffused light and instrumental distortion. M. W. OVENDEN

523.77 : 523.877

8461. Solar atomic lines in the 3-μ region. O. C. MOHLER. Letter in *Phys. Rev.*, **83**, 464 (*July* 15, 1951).

Improved wavelengths and confirmation of solar origin by observed rotational Doppler shifts are found for 4 lines. D. L. EDWARDS

523.775.1

8462. On the disappearance of the continuous spectrum in the flash spectra. S. UENO. *Publ. Astron. Soc. Japan*, **2** (*No.* 2) 61–5 (1950).

By using the continuous absorption coefficients of the H atom and its negative ion, the intensity of the continuous spectrum in the flash spectra was computed for certain geometrical heights, with the chromospheric temperatures 4 793° K and 5 700° K, at the wavelengths $\lambda\lambda$ 8203$_+$, 8203$_-$, 6000, 4000, 3647$_+$, 3647$_-$, and 3300. It can be inferred from the figures that the continuous spectrum in the flash spectra disappears, in general, progressively from the violet to the red region. The inverse progress occurs at the limits of the Balmer and the Paschen series. These phenomena are closely related to the excitation condition of the chromosphere. A.

523.85

8463. On the probability distribution of the field strength of fluctuating forces in stellar systems. B. TAKASE. *Publ. Astron. Soc. Japan*, **2** (*No.* 1) 1–13 (1950).

The probability distribution of the strength of gravitational field which arises from a random distribution of stars in stellar systems is considered. Expressing the state of spatial distribution of stars in a stellar system with "randomness factor" $\chi(r)$ as a function of the distance r from a representative star on some assumptions, the law of the probability distribution was obtained by means of Markoff's statistical method. A comparison is made with the Holtsmark distribution which corresponds to the case where the second term of the exponent in this expression vanishes. As a further application of the present calculation the expression for the time of relaxation of the stellar system was obtained. A.

523.85

8464. The mass of the globular clusters. R. KURTH. *Z. Astrophys.*, **29** (*No.* 1) 26–8 (1951) *In German.*

Theoretically computed masses for 8 globular clusters range from $5{\cdot}9\times10^4\,M_\odot$ (Messier 5) to $5{\cdot}4\times10^6\,M_\odot$ (Messier 16), with a mean mass $\sim 10^5\,M_\odot$. D. R. BARBER

523.85

8465. The evolution of the globular clusters. R. KURTH. *Z. Astrophys.*, **29** (*No.* 1) 33–65 (1951) *In German.*

Dynamical methods are used to construct a model, which, though mathematically inexact, suffices to provide criteria of certain initial physical parameters, e.g. radius, and density; also the age of the globular system, viz. $\sim 10^7$ to 10^8 yr. D. R. BARBER

523.851

8466. Distance determination of open clusters using the method of colour differences. W. BECKER. *Z. Astrophys.*, **29** (*No.* 1) 66–72 (1951) *In German.*

This new method leads to the distance modulus and the interstellar reddening of an open cluster without the necessity of knowing the spectral types of its members; it can also be used for very dense and faint clusters which until now could be dealt with only by the diameter method. A. BEER

523.851 : 523.842

8467. Stellar grouping and the origin of stars. W. A. AMBARZUMIAN. *Abh. Dtsch. Akad. Wiss. Berlin, Kl. Math. allg. Naturwiss., No.* 2, 10 *pp.* (1950) *In German.*

A short review of recent theory and observation relating to the distribution of galactic stellar material in open and globular clusters, and double-, triple- and multiple-star systems. No references are given. D. R. BARBER

523.852

8468. Mechanical models of nebular clusters. G. LEMAÎTRE. *Bull. Acad. Roy. Belge. Cl. Sci.*, **37** (*No.* 4) 291–306 (1951) *In French.*

It is assumed that nebulae move under the action of gravitation and cosmic repulsion, and that, on account of high velocities, individual nebulae may leave the cluster, being replaced by others entering from the general nebular field. Earlier calculations for infinitesimal concentrations [Abstr. 3706 (1949)] are extended to the non-static case for "quasi-isotropic" distributions for which the region occupied in velocity-space has the same volume as a sphere whose diameter is defined by the radial velocities only. R. A. NEWING

523.852.21

8469. On a special class of diffuse gas nebulae. G. A. SHAÏN AND V. F. GAZE. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 431–3 (1951) *In Russian.*

The class referred to is characterized by the concentration of the mass along the "periphery" or at least at some distance from the centre, which does not exclude the existence of luminous masses at the centre as well. The configuration may be circular, closed or open, irregularly elliptical, single or branched arcs of various central angles. The structure of this type is in a marked contrast to the accepted conception of diffuse nebulae as some irregular, amorphous formations. The authors photographed about 140 independent diffuse nebulae (among which 105 new ones) of which 14 were of the special type. These are tabulated and partly shown in photographs. Certain interesting parallels in the relation between nebulae and the exciting stars on one hand, and the planetary nebulae and their central stars, on the other hand are pointed out, viz. a genetical relation which doubtless exists. The stars concerned belong in the case of the diffuse nebulae to the O and B0 classes. B. F. KRAUS

523.852.22

8470. On the radiation field of the planetary nebulae. S. MIYAMOTO. *Publ. Astron. Soc. Japan*, **2** (*No.* 1) 23–31 (1950).

Following H. Zanstra, the radiation field of the planetary nebulae has been treated, taking into account the non-coherency of the Lyman alpha scattering, and assuming the Maxwell contour instead of the rectangular one. Zanstra's formulation of the problem essentially leads to an integral equation, and it is difficult to solve. If the Maxwell distribution is replaced by the step function, the fundamental equation is reduced to the system of linear differential equations of first order with constant coefficients. The simplest model of contour, consisting of the central part of very large absorption coefficient, and of the outer skirt, where the absorption coefficient is equal to the continuous Lyman radiation, has been treated. This model leads to the conclusion that the intensity of the Lyman alpha radiation is equal to that of ultraviolet radiation in its order of magnitude, contrary to the current estimation, which predicts large accumulation of Lyman alpha radiation inside the nebulae. The Lyman alpha flux and hence the Lyman alpha pressure is reduced largely. It is equal to that of the ultraviolet pressure, except the very outer boundary of the nebulous shell, where it exerts about 100× stronger pressure. A.

523.85

8471. The theory of the fluctuations in brightness of the Milky Way. III. S. CHANDRASEKHAR AND G. MÜNCH. *Astrophys. J.*, **114**, 110–22 (*July*, 1951)

For Pt II, see Abstr. 2345 (1951). The integral equation derived in Part I governing the fluctuations in brightness of the Milky Way is explicitly solved for the case in which the system extends to a finite distance in the direction of the line of sight and where all the clouds are equally transparent. The derived theoretical distributions are illustrated. A.

523.854.

8472. Infra-red luminosity of the celestial arch in the region of the Milky Way. S. F. RODIONOV AND I. G. FRISHMAN. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 6) 997–9 (1951) *In Russian.*

This article describes the steps taken in the autumn of 1950 to measure the infra-red luminosity of the celestial arch in greater detail than had been achieved earlier in the year. A photometer was used with a smaller visual angle than that then employed and measurements were registered on Mount Elbrus (2 200–3 100 m above sea-level). Results are shown

graphically for (1) the star verticals of α Perseus and α Cygnus; (2) the almacantars of some conspicuous stars of the Galaxy (α Aquila, γ Cygnus, etc.); (3) the general distribution of infra-red luminosity (a) in relation to the zenith (b) at 55°. Maximum luminosity was indicated in the Cygnus region. It is conjectured that the considerable infra-red radiation of the Milky Way can be referred to the presence of a large number of cold stars with radiation mainly in the infra-red parts of the spectrum. J. CLEUGH

523.854.1

8473. Visibility corridors and regional differences of the stellar structure in the galaxy. B. A. VORONTSOV-VELYAMINOV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 425–6 (1951) *In Russian.*

The detailed investigation of long-period Cepheids and stellar agglomerations showed that they form the same kind of visible associations in the sky as hot giants, in the same regions and on a comparable area of the sky. Although the correspondence obviously cannot be complete, the parallel is quite striking in a surprisingly high number of cases, and regularly these groups are surrounded by apparently "empty" zones. The existence of such corridors of visibility is also confirmed by the investigation of the distribution of long-period variables and planetary nebulae. The question of the neighbouring impenetrable regions remains, however, unsolved, as they must also contain hot giants, it being known from many examples that associations of these stars cover areas of hundreds of parsecs linear dimension. B. F. KRAUS

523.872

8474. On the spectrum of Nova EU Scuti 1949. P. WELLMANN. *Z. Astrophys.*, **29** (*No.* 1) 101–4 (1951) *In German.*

Discussion of the absorption spectrum given by two plates obtained with the 1 m reflector of the Hamburg–Bergedorf Observatory, and comparison with Ch. Fehrenbach's results obtained a week earlier [*Publ. Obs. Haute-Provence: B, No.* 25 (1949)] as well as with a very similar phase of Nova Herculis, 1934. A. BEER

523.877

8475. A note on the problem of the stellar envelopes and the central condensation of the stars. K. OSAWA. *Japan. J. Astron.*, **1** (*No.* 1) 1–6 (1949).

Chandrasekhar's treatment of the problem of stellar envelopes and of the central condensation of stars is supplemented by a graphical method. It is assumed that the envelope contains only 10% of the total mass, that the material is an ideal gas, that the opacity obeys Kramers' law, and that no energy is generated in the envelope. A. BEER

523.877

8476. On the equation for the transfer of the Lyman continuum radiation in the circumstellar atmosphere. W. UNNO. *Japan. J. Astron.*, **1** (*No.* 1) 27–35 (1949).

Hagihara's equation of radiative transfer is developed to a form capable of unique solution, and direct application to the problem of circumstellar atmospheres; in particular, the transfer of the diffuse Lyman continuum radiation. D. R. BARBER

523.877

8477. On the convection of the stellar photospheres. S. UENO AND S. MATSUSHIMA. *Publ. Astron. Soc. Japan*, **2** (*No.* 1) 32–44 (1950).

Mathematical expressions to describe the stellar photospheric structure, and convective instability, have been derived for both main-sequence, and giant stars of spectral class, A0, F0, G0, K0 and M2, taking account of opacity due to atoms and — ve ions of H. A hitherto unrecognized feature of the radiative temp. gradient in the later-type stars, is a weak max. appearing at the transition, K0–M2, which is attributed to the — ve H ion. D. R. BARBER

523.877

8478. A model atmosphere for an early O-type star. A. B. UNDERHILL. *Publ. Dom. Astrophys. Obs., Vict., B.C.*, **8** (*No.* 12) 357–84 (1951).

A model atmosphere in mechanical and radiative equilibrium has been computed for a boundary temperature of 35 000° and log $g = 4{\cdot}200$. The integrated flux corresponds to $T_e = 44\,600°$. The model is in radiative equilibrium throughout. Tables are given showing the structure of the model, and the variation with depth of ρ, the density, and $\bar{\kappa}$(H), $\bar{\kappa}$(HeI) and $\bar{\kappa}$(HeII), the mean opacity coefficients due to H, neutral He and ionized He, respectively. It is shown that H is the chief source of opacity throughout most of the atmosphere in spite of its almost complete ionization, with ionized He next. The radiation pressure is larger than the gas pressure through most of the atmosphere. The ionization of H is practically complete, $(1 - x_H) \sim 10^{-6}$, as is the first ionization of He. The second ionization of He is nearly complete, the fraction of twice ionized He atoms being of the order of 0·95 or more through most of the atmosphere. A table is given showing the spectral intensity distribution of the continuous flux at 5 levels. The relation of the varying monochromatic optical depth in each spectral region to the "characteristic" temperature of the emergent radiation is discussed. The spectral type of the model atmosphere is estimated to be O5 V. A.

523.877

8479. On the luminosity effects of the hydrogen lines in O-type spectra. A. B. UNDERHILL. *Publ. Dom. Astrophys Obs. Vict., B.C.*, **8** (*No.* 13) 385–99 (1951).

The Stark effect of H in stellar atmospheres is reviewed with a view to determining the luminosity effects to be expected in the O stars. It is shown that the characteristic Stark wings of Hγ will disappear in main-sequence O-type stars and that this line will have a profile determined mainly by thermal or turbulent Doppler effect and by radiation or collision damping of the dispersion type. Consequently no luminosity effects are expected in the early members of the Balmer series of H in the O-stars. It is expected that the Stark wings of the later members of the series will persist. It is shown that the early members of the Lyman series will not be affected by Stark effect in main sequence stars or in giant stars, and that the extent of the wings of the Lyman lines in O-type spectra is not large. A.

523.877

8480. Notes on stellar spectra. O. STRUVE. *Publ. Astron. Soc. Pacif.*, **63**, 138–41 (*June*, 1951).

In ε Aurigae striking differences in the profiles of individual lines, especially of Ti II, from low metastable levels and Fe II, suggest that a large portion of the atmosphere may consist of a network of prominences rather than uniform gas. This is supported by the diffuseness of the Paschen as compared with the Balmer lines. D. L. EDWARDS

525.35

8481. Motions of the rotation axis of the elastic earth relative to the earth's body and to the space. N. SEKIGUCHI. *Publ. Astron. Soc. Japan*, **2** (*No.* 2) 74–82 (1950).

A theory of the rotation of the elastic earth is developed without reference to effects arising from oceanic motions, and other causes. Results are compared with those based on an assumed rigid earth, and it is concluded that the former agree better with observation. D. R. BARBER

525.35

8482. On the movement of the earth round its centre of gravity. K. POPOFF. *Bull. Astron., Paris*, **16** (*No.* 2) 121–9 (1951) *In French.*

525.35

8483. The seasonal fluctuations in the rotation of the earth. N. STOYKO. *Bull. Acad. Roy. Belge, Cl. Sci.*, **37** (*No.* 4) 378–92 (1951) *In French.*

The intercomparison of various national time services is examined with special consideration given to the stability of rotation fluctuations in phase and amplitude and the possibility of reducing results to a "quasi-uniform" time. M. W. OVENDEN

526.17

8484. A note on the errors involved in the calculation of elevations of the geoid. A. H. COOK. *Proc. Roy. Soc. A*, **208**, 133–41 (*Aug.* 7, 1951).

Discusses the errors likely to occur in calculations of the elevation of the geoid by Stokes's formula when gravity data outside a given cap are neglected, and it is shown that they are comparable with the root-mean-square elevation. It is shown that these estimates and those of similar errors in deflexions of the vertical made earlier [Abstr. 1592 (1951)] are not seriously affected by the assumptions made about the distribution of gravity anomalies between the harmonics up to degree 18. A.

526.7

8485. The gravitational declination, its determination and elimination. A. BERROTH. *Geofis. Pura Appl.*, **19**, 117–23 (*April–June*, 1951) *In German.*

The gravitational declination appears here as the analogue of magnetic declination. The photographic recording theodolite in connection with a high-frequency impulse transmitter allows, by a method of simultaneity of two field stations, its direct and connected measurement and its elimination with regard to geodetic directions. The method has been based on linear equations, demanding only horizontal angle measurements on a simple system of stars, eliminating need for transportable clocks. The method promises a higher accuracy and a greater speed of working than existing methods. A.

526.7

8486. The first order term of the indirect effect J. GOGUEL. *Ann. Geophys.*, **7** (*No.* 3) 163–8 (1951) *In French.*

In Vening Meinesz's theory of the indirect effect o isostatic compensation [*Bull. Géod.* (July, 1946)] th first-order term is indeterminate. The significance o this term is discussed. The 1st-order term in th topography and compensation is equivalent to dipole at the centre of the earth and it is shown tha the centres of concentric spherical shells of constan density inside the earth are displaced by a constan amount. The total external field is that due to thes displaced shells together with that of the dipol equivalent to the topography and compensation an there are then three centres to consider, the centre o figure of the surface, the centre of internal attraction that is, the centre of pressure, and the centre o attraction of the external field, the same as the centr of inertia. It is the difference between the first an the last that is the 1st-order term of the elevation o the geoid corresponding to the 1st-order term of th indirect effect. A. H. COOK

526.7

8487. The indirect effect and the interpretation o gravity anomalies. P. LEJAY. *Ann. Geophys.*, (*No.* 3) 169–92 (1951) *In French.*

When isostatic anomalies are used in the calculatio of the form of the geoid, the indirect effect, th difference between gravity anomalies referred to th geoid and those referred to the co-geoid of th isostatically compensated earth, must be considered The correction for the difference between the geoi and the co-geoid may be taken to be the free ai correction since the use of isostatic anomalies i just a device for calculation. [To obtain the form o the geoid of the actual earth from that of the co-geoi of the compensated earth with the topography an compensation anulled the effects of these must b replaced.] For geophysical purposes the total effec of the removal of topography and compensatio including the effect of changes of internal equipotentia surfaces dividing shells of different densities (oute mantle, inner mantle, core) must be considered A paper by Meinesz (*Bull. Geod.*, July, 1946) whic includes all these effects in a discussion of the indirec effect, is summarized with a few modifications. Th changes in the internal equipotential surfaces due t the removal of topography and compensation ar calculated. The treatment of the harmonic o 1st order is discussed and it is pointed out that if i is not included correctly a spurious 1st-order harmoni will appear in the gravity anomalies. The practica calculations of the separation of the geoid and co geoid and of the corrections to be applied to gravit values are outlined. A. H. COO

526.77

8488. Regional correction of gravity data. R. VAJK *Geofis. Pura Appl.*, **19**, 129–43 (*April–June*, 1951).

A historical review of the average gradient metho used in torsion balance data is given. The connectio between the averaging, or grid method, used on th gravity meter data and the average gradient method i pointed out and a criticism of these methods is given The method of smoothing the isogams and gravit

curves is also discussed. A few suggestions are made for breaking the gravity data into two components (regional and residual) by the analysis of the gravity data. Finally the application of the second derivative methods for the elimination of the regional effect is discussed. A.

PHYSICS 53

53

8489. American experimental physics—trends in method and technique. C. J. OVERBECK. *J. Sci. Instrum.*, **28**, 257–69 (*Sept.*, 1951).

53

8490. A unified approach to physics. N. C. LITTLE. *Amer. J. Phys.*, **19**, 351–3 (*Sept.*, 1951).

The general elementary course is unified on a basis of underlying theory. Five fundamental concepts are introduced to serve a dimensional analysis for the whole of physics. Selected topics make the nature of these concepts clear, e.g. (1) geometric optics for length, (2) kinematics for time, (3) statics of a rigid body for force, (4) electrolysis for electricity, and (5) thermometry and calorimetry for temperature. Five sections follow which cut horizontally across the conventional subdivisions of physics. (1) Energetics in which dynamics, thermodynamics, and the relativity mass-energy relation find a place; (2) Flow Phenomena stress the parallelisms between fluids, heat and electricity; (3) Field Phenomena apply the inverse square law to gravitation, electro- and magnetostatics, photometry and radiation; (4) Periodic Phenomena, starting with circular and simple harmonic motions, end with waves of all kinds; and (5) Quantum Phenomena deal with the elemental particles and the indeterminancy principle. A.

53.081

8491. Fundamental and derived [physical] quantities. R. W. POHL. *Naturwissenschaften*, **38** (*No.* 11) 247–8 (1951) *In German.*

A discussion on units. Tries to show clearly why it is necessary to introduce electrical in addition to mechanical units. Pleads that the Gaussian use of "absolute" as the antonym of "relative" be reintroduced. S. WEINTROUB

53.081 : 621.3.081.1

8492. The systems and units of dimensions of electric and magnetic quantities. O. FRANKE. *Elektrotech. u. Maschinenb.* [*EuM*] **68**, 280–4 (*June* 1); 323–7 (*July* 1); 344–9 (*July* 15); 378–83 (*Aug.* 1, 1951) *In German.*

The definition of units and measuring quantities of physical magnitudes and their interrelations is first discussed in general mathematical terms. There is a complete analogy between physical equations and equations between the chosen units in a consistent system of units. This reduces the number of units which can be chosen freely for a system defined by n physical equations containing n physical magnitudes to $n - m$. The theory of the electromagnetic field is shown to involve 12 unknown magnitudes which must satisfy 8 fundamental equations. There are consequently 4 units which may be chosen arbitrarily. 3 units, namely length, mass and time, are fixed by either the c.g.s.- or the MKS-system so that only one more unit is open to choice. The author proposes to choose the vacuum-permeability because it can be defined by a physical arrangement which is reliable. Alternatively he proposes the Ohm but he does not favour the Ampere on account of the accuracy of its basic definition still being insufficient. Relations between the dimensions of physical equations and the constants which are open to choice are discussed in detail. The most important systems of units and constants (unrationalized as well as rationalized) are tabulated. Another table indicates the interrelations between the chosen independent units and the resulting dependent units for the absolute electrostatic, the Giorgi and the Kalantaroff systems. These relations are simplest in the Kalantaroff system. Its adoption is, however, not recommended because it veils the relation between a magnitude and the basic units. Methods of defining the absolute units of Ohm and Ampere are considered and the realization of the absolute Ampere by the weighing method of Kelvin and Rayleigh is discussed.

E. FRIEDLANDER (R)

FUNDAMENTALS 530.1

530.12

8493. A six-vector development of some results in kinematical relativity. R. A. NEWING. *Quart. J. Math., Oxford Ser.* **2**, **1**, 153–60 (1950).

It is shown how some of the results in Milne's book, "Kinematic Relativity," can be derived by using the 4-dimensional invariants of space-time, and, in particular, six-vectors.

MATHEMATICAL REVIEWS

530.12

8494. The compatibility of the equations of unitary field theory. M.-A. TONNELAT. *C.R. Acad. Sci., Paris*, **232**, 2407–9 (*June* 25, 1951) *In French.*

It is shown that earlier equations [Abstr. 3744 (1950)] are not inconsistent with the underlying affine geometry. J. R. MADDOX

530.145

8495. On a one-one correspondence between infinitesimal canonical transformations and infinitesimal unitary transformations. D. C. RIVIER. Letter in *Phys. Rev.*, **83**, 862 (*Aug.* 15, 1951).

Corresponding to each classical function $F^c(q, p)$ is defined a Hermitian well-ordered, quantum-mechanical operator $F(q, p)$ (reducing to $F^c(q, p)$ as $\hbar \to 0$). From this, the infinitesimal unitary transformation corresponding to the infinitesimal canonical transformation derived from $F^c(q, p)$ is obtained.

R. H. DALITZ

530.145

8496. On relativistic quantum mechanics and the mass operator. W. Wessel. *Phys. Rev.*, **83**, 1031–7 (*Sept.* 1, 1951).

The theory of the electron developed by Bopp, Hönl and the author is discussed in relation to the relativistic wave equation of Gelfand and Yaglom, with particular regard to the infinite, Hermitian representations of its matrix apparatus. It is shown that the ambiguity left in the work of the Russian authors is completely removed in this formulation. Only the form of the mass operator, which depends, in Bopp's interpretation, on the cut-off function in the Born-Bopp variation principle, remains uncertain. It is shown that in the infinite representations the mass operator must necessarily depend on one of the invariants (K) of the momentum tensor, because otherwise its eigenvalues would have a point of accumulation at zero. In order to avoid this possibility, the diagonal transformation of the invariant in question is accomplished, and a necessary condition for the analytic form of the mass operator is established, which considerably restricts its choice.

A.

530.145

8497. The quantum-mechanical equations of motion and commutation relations. C. R. Putnam. *Phys. Rev.*, **83**, 1047–8 (*Sept.* 1, 1951).

It has been shown by Wigner that the equations of motion of a quantum-mechanical system with a Hamiltonian $H = \frac{1}{2}p^2 + V(q)$ need not imply the commutation relation $i[p, q] = 1$. Particular examples are furnished by the free particle and the harmonic oscillator. On the other hand, Wigner points out that the above commutation rule does follow from the equations of motion if $V(q)$ is of the form $V = aq + b$ or $V = aq^3$. In the present note, this latter result is generalized to the case of an arbitrary potential $V = aq^n + b$, where n is an odd integer; the last-named potentials are, in fact, particular cases of those satisfying a general criterion contained in the article.

A.

530.145

8498. Contributions to the Schrödinger non-symmetric affine unified field theory. R. L. Ingraham. *Ann. Math.*, **52**, 743–52 (1950).

For the theory see Abstr. 26, 1761 (1948). The field equations are put into a form which, with the imposition of additional conditions, yields analogues of the electromagnetic and gravitational field equations. The equations of motion of particles are discussed. An exact solution of the field equations is set up.

MATHEMATICAL REVIEWS

530.145

8499. On the particle picture of quantized Bose fields. I. J. L. Lopes. *An. Acad. Brasil. Cienc.*, **23** (*No.* 1) 39–60 (1951).

For a non-interacting Klein-Gordon Bose field (real or complex), a covariant "number-of-quanta" operator is obtained, using which the positive and negative frequency components of the field operator, and finally the Fock wave-functions are obtained as functions of their values and normal derivatives on a given space-like surface. The Hamiltonian and the equation of motion are written also in Fock representation in co-ordinate space. A non-local 4-vector matter-density operator is defined, and it is noted that a theory describing particles with one sign of charge cannot be constructed using this operator.

R. H. DALITZ

530.145

8500. Behavior of *D*-function in Yukawa's non-local field theory. Y. Ôno and M. Sugawara. *Progr. Theor. Phys.*, **6**, 182–7 (*March–April*, 1951).

It is shown that the D' function of Yukawa's non-local field theory [Abstr. 3762 (1950)] is singular on a wedge whose axis lies in the direction of the relative co-ordinate, vanishing outside the wedge.

R. H. DALITZ

530.145

8501. Existence of solutions of the operational equation of evolution. R. Guy. *C.R. Acad. Sci., Paris*, **233**, 288–90 (*July* 23, 1951) *In French.*

The existence of a solution of the operator integral equation of Visconti [*C.R. Acad. Sci., Paris*, **230**, 1744 (1950)] is proved, when the kernel is a bounded linear operator.

R. H. DALITZ

530.145

8502. Constraints in covariant field theories. J. L. Anderson and P. G. Bergmann. *Phys. Rev.*, **83**, 1018–25 (*Sept.* 1, 1951).

Certain problems are considered which arise when an attempt is made to cast a covariant field theory into a canonical form. Because of the invariance properties of the theory, certain identities exist between the canonical field variables. To insure that the canonical theory is equivalent to the underlying Lagrangian formalism one must require that these identities, once satisfied, will remain satisfied through the course of time. In general, this will be true only if additional constraints are set between the canonical variables. It has been shown that only a finite number of such constraints exist and that they form a function group. The proof rests essentially on the possibility of constructing a generating function for an infinitesimal canonical transformation that is equivalent to an invariant infinitesimal transformation on the Lagrangian formalism. Once a Hamiltonian is obtained by one of the procedures outlined in previous papers of this series, and the constraints have all been found, the consistent, invariant canonical formulation of the theory is completed. The main results of the paper have been formulated in such a manner as to make them applicable to a fairly general type of invariance. In the last sections these results are applied to the cases of gauge and coordinate invariance. In the latter case a Hamiltonian corresponding to a quadratic Lagrangian, has been constructed in a parameter-free form; and in both cases the constraints, together with the Poisson bracket relations between them, have been obtained explicitly. As was to be expected, two constraints were found for a gauge-invariant theory and eight for a coordinate-invariant theory.

A.

530.145

8503. Some quantum-mechanical divergences of a simple field. W. SOLLFREY AND G. GOERTZEL. *Phys. Rev.*, **83**, 1038–44 (*Sept.* 1, 1951).

In order to study the sources of quantum-mechanical divergences, an elementary model, consisting of a one-dimensional vibrating string elastically coupled to a harmonic oscillator, is studied in detail. Following a preliminary discussion of the classical eigenfunctions of the coupled system for both a finite and an infinitely long string, the system is quantized by the standard methods of boson field theory. The permissible experiments upon the system are investigated from the viewpoint of regarding the measuring apparatus as providing initial conditions for the system. It is shown that certain infinities are of mathematical origin, and arise from breakdown of perturbation theory. Others are physical, and are the result of prescribing impossible requirements for the measuring apparatus. Cut-off methods which remove the infinities are presented. A.

530.145

8504. Erratum: The angular correlation theorem and the elimination of interference terms. H. A. TOLHOEK AND S. R. DE GROOT. Letter in *Phys. Rev.*, **83**, 845 (*Aug.* 15, 1951). See Abstr. 6739 (1951).

530.145

8505. On the problem of covariance in quantum electrodynamics, II. J. YUKAWA AND H. UMEZAWA. *Progr. Theor. Phys.* **6**, 197–201 (*March–April* 1951).

For Pt I, see Abstr. 7520 (1951). The energy-momentum tensor of a photon is obtained, to order e^2; the conditions that this be covariant and gauge invariant are just those required for vanishing photon self-energy. Also the Pais formula for self-stress is shown applicable to the photon. R. H. DALITZ

530.145

8506. On a formulation of quantum electrodynamics. J. G. VALATIN. Letter in *Phys. Rev.*, **83**, 850 (*Aug.* 15, 1951).

In a formally covariant way, the e.m. interaction is separated into interaction with photons and a direct Coulomb interaction, represented here as due to coupling through a further vector field. The commutation relations are discussed; the formalism leads to the usual S-matrix. R. H. DALITZ

530.145

8507. The Schrödinger equation in quantum electrodynamics. F. J. DYSON. *Phys. Rev.*, **83**, 1207–16 (*Sept.* 16, 1951).

Concluding a programme begun in earlier papers, this paper is occupied with the analysis of the Hamiltonian occurring in the Schrödinger equation of quantum electrodynamics in a new representation called the intermediate representation. It is proved that the Hamiltonian is free of divergences, either explicit or implicit. The intermediate representation therefore provides a complete divergence-free formulation of quantum electrodynamics, applicable to all physical situations. The divergences which are eliminated are the well-known ultraviolet divergences. The Hamiltonian is still expressed as a power series in the fine-structure constant; the convergence of the series is not proved. A.

530.145

8508. On the theory of exchange effects of a particle with the quantum field. S. V. TYABLIKOV. *J. Exp. Theor. Phys., USSR*, **21**, 16–24 (*Jan.*, 1951) *In Russian.*

The exchange effect calls into play the effective mass of the particle and uncertainty in its coordinate. Both quantities also depend on the temperature of the field. The exchange effect of a particle with scalar and electromagnetic fields is discussed. J. JACOBS

530.145

8509. Radiation corrections to Dirac's equation (in nonrelativistic approximation). A. A. ABRIKOSOV AND I. M. KHALATNIKOV. *J. Exp. Theor. Phys., USSR*, **21**, 69–78 (*Jan.*, 1951) *In Russian.*

The shift of electronic energy levels in the external field due to exchange effects with the emission field is calculated. Omission of terms not belonging to the external field simplify earlier calculations.

J. JACOBS

530.145

8510. Note on the direct interaction between spinor fields. S. KAMEFUCHI. *Progr. Theor. Phys.*, **6**, 175–81 (*March–April*, 1951).

Assuming a scalar β-decay coupling between nucleon and lepton fields, it is shown that, to 2nd order, the self energies of all four fields are renormalizable but that the matrix element for mutual scattering of two particles is divergent and unrenormalizable. R. H. DALITZ

530.145

8511. On the nuclear potential in the meson theory. Y. ATAKA. Letter in *Progr. Theor. Phys.*, **6**, 256–8 (*March–April*, 1951).

It is shown that the familiar r^{-3} singularity does not appear in properly relativistic wave-equations unless the meson-field is of vector type with tensor coupling. J. R. MADDOX

530.145

8512. Radiative corrections to anomalous magnetic moment of nucleon in pseudoscalar meson theory. K. NAKABAYASI AND I. SATO. Letter in *Progr. Theor. Phys.*, **6**, 252–4 (*April*, 1951).

Feynmann–Dyson calculation of corrections up to the fourth-order. The higher terms are large and consistent with large values of the coupling constant, which suggests that weak-coupling theory is invalid.

J. R. MADDOX

530.145

8513. On the universal Fermi-type interaction. I. E. R. CAIANIELLO. *Nuovo Cim.*, **8**, 534–41 (*Aug.*, 1951).

The question of the possibility of a universal Fermi-type interaction is re-examined. It is found that the answer may be positive, provided one accepts the possibility of two-neutrino annihilations of particle-antiparticle pairs; the cross-sections for these last processes turn out, however, to be exceedingly small. These considerations are exemplified with a particular Hamiltonian for the purpose of estimating at least qualitatively the prediction of such a theory: no claim is made as to the correctness of this choice. A.

530.145

8514. The differential cross section for high energy nucleon-nucleon collisions. H. S. GREEN AND H. MESSEL. Letter in *Phys. Rev.*, **83**, 842 (*Aug.* 15, 1951).

Assuming an angular distribution $R(E) + S(E)\cos^2\theta$ in c.m. system for inelastic nucleon-nucleon collision the functions R and S are derived from an integral equation, when total lab. cross-section is known as function of incident energy. From this theory and from data on cosmic-ray nucleon cascades, the r.m.s. scattering angle for single ultra-relativistic nucleon-nucleon collision is $2(E_0/Mc^2)^{-\frac{1}{2}}$ radians in lab. system. R. H. DALITZ

530.145

8515. On the interaction of two electrons. G. E. BROWN AND D. G. RAVENHALL. *Proc. Roy. Soc. A*, **208**, 552–9 (*Sept.* 24, 1951).

A relativistic wave equation for He-like systems which gives energy levels correct to within α^2Ry is derived from quantum electrodynamics, care being taken in the handling of pair-production processes. Calculations made with it agree to this accuracy with Breit's calculations. A.

530.145

8516. The interaction of the Dirac magnetic monopole with matter. W. V. R. MALKUS. *Phys. Rev.*, **83**, 899–905 (*Sept.* 1, 1951).

It has been previously determined that an electron has no bound states in the field of the magnetic monopole. Seeking to establish the character of the monopole's interaction with the more complex fields of atoms and molecules, this paper investigates charged particles, of arbitrary magnetic moment, moving simultaneously in the field of the monopole and an external electric field. It is concluded that the monopole can be coupled to matter with energies comparable to, but not significantly greater than, the chemical bond, reservations being made in the case of hydrogen where the lowest energy state depends upon the mass of the monopole. Speculation regarding the creation of monopoles by primary cosmic radiation and their consequent motion in the earth's magnetic field instigated an experimental attempt to arrive at an upper limit for the rate of such creation. The results of this experiment determine that the number of monopoles arriving at the surface of the earth is less than 10^{-10} per cm^2 per sec. A.

530.145

8517. The fourth-order contribution to the self-energy of the electron. R. M. FRANK. *Phys. Rev.*, **83**, 1189–93 (*Sept.* 15, 1951).

The self-energy of a free electron is calculated to order e^4. The modification of quantum electrodynamics suggested by Feynman is used to make the matrix elements finite. After mass renormalization, using the self-energy to order e^2, there remain four Feynman diagrams whose matrix elements must be calculated. Two of these represented the two ways in which two virtual quanta may be emitted and absorbed by the electron, both quanta being present at the same time. The third diagram represents the emission of a virtual quantum which creates a virtual pair, the quantum produced by the pair annihilation being absorbed by the electron. The last diagram corresponds to the emission and absorption of a virtual quantum accompanied by a mass renormalization. The matrix elements involve an integration over the momenta of all virtual quanta present in each diagram. These integrals are approximated by assuming that the Feynman cutoff, λ, is large compared to the electron mass. It is found that the result depends upon $(\ln\lambda)^2$, but it is not the square of the second-order self-energy. A

530.14

8518. On the relation between the three Dirac matrices. V. S. VRKLJAN. *Glasn. Mat.-fiz. Astron.* **6** (*No.* 1–2) 49–56 (1951) *In German.*

A consideration of some properties of particular representations of the Dirac matrices in which separation of the wave function into large and small components is convenient. R. H. DALITZ

530.14

8519. Theories of particles of higher spin. P. URBAN AND F. SCHWARZL. *Acta Phys. Austriaca*, **4** (*No.* 4) 380–404 (1951) *In German.*

Review and exposition of previous discussions depending on spinor analysis. J. R. MADDOX

530.14

8520. On the inner parity of the positron. V. B. BERESTETSKIĬ. Letter in *J. Exp. Theor. Phys., USSR*, **21**, 93–4 (*Jan.*, 1951) *In Russian.*

The nonrelativistic electron is described by a spinor, the positron by a pseudospinor, i.e. they are of opposite inner parity. J. JACOBS

530.14

8521. Perturbation of the "phase memory" of a spin system by fluctuations in time of the magnetic field. R. GABILLARD. *C.R. Acad. Sci., Paris*, **233**, 307–9 (*July* 23, 1951) *In French.*

A theoretical interpretation is given and experimental verification described. A new method for measuring T_2 is suggested. L. PINCHERLE

530.14

8522. On the mass of the cohesive meson and the mass difference of nucleons. H. ENATSU AND P. Y. PAO. Letter in *Progr. Theor. Phys.*, **6**, 261–2 (*March–April* 1951).

An omission is noted in the calculation by Kawabe and Umezawa [Abstr. 5527 (1950)] of the neutron proton mass difference in cohesive meson theory. Including this it is found possible to account for the observed mass difference with a reasonable cohesive meson mass. R. H. DALITZ

530.14

8523. Erratum: On the evaluation of the *S*-matrix. F. COESTER. Letter in *Phys. Rev.*, **83**, 1066 (*Sept.* 1, 1951). See Abstr. 4103 (1951).

530.14

8524. Field corrections to neutron-proton scattering in a new mixed meson theory. D. B. BEARD AND H. A. BETHE. *Phys. Rev.*, **83**, 1106–14 (*Sept.* 15, 1951).

The principal relativistic correction to neutron proton scattering has been computed to 4th order for nonrelativistic energies by calculating the matrix elements using the Feynman method and then subtracting off the appropriate order Born approximation to the Yukawa potential. A new meson theory was

used, namely a mixture of pseudovector mesons and pseudoscalar mesons with pseudovector coupling; it is shown that by suitable choice of the coupling constants the divergent terms could be eliminated in all orders (disregarding possible electromagnetic couplings). The mesonic field corrections to neutron-proton scattering were found to be of order μ/M smaller than the static Yukawa potential cross-section; in practical applications, they could be treated as a perturbing potential to the static Yukawa interaction. A.

530.145

8525. Neutral photomeson production and nucleon isobars. K. A. Brueckner and K. M. Case. *Phys. Rev.*, **83**, 1141–7 (*Sept.* 15, 1951).

The magnitude of the neutral photomeson cross-section, which is comparable with the cross-section for charged mesons, is not given correctly by weak coupling perturbation theory. In fact, the phenomenon appears to depend on a nonlinear behaviour of the meson fields corresponding to intermediate or strong coupling. Accordingly, the effect of the existence of nucleon isobars, which is one of the most characteristic features of strong coupling theory, has been investigated through the use of a classical model and is found to give the general features and magnitude of the neutral cross-section correctly. The isobars are predicted to be unstable with an excitation energy of three or four hundred MeV. A.

530.145

8526. Remarks concerning the adiabatic theorem and the *S*-matrix. H. S. Snyder. *Phys. Rev.*, **83**, 1154–9 (*Sept.* 15, 1951).

An improved mathematical formulation and solution of transition rate problems for scattering and reaction problems is given. Difficulties in connecting the time dependent and stationary methods of defining the *S*-matrix are noted, but not resolved. A.

530.145 : 538.11

The energy loss of free magnetic poles in passing through matter. *See Abstr.* 8833.

530.145 : 539.185

8527. On the electromagnetic radiation during neutron-proton collision. G. M. Avakyants. *J. Exp. Theor. Phys., USSR*, **20**, 944–6 (*Oct.*, 1950) *In Russian.*

The cross-section for electromagnetic radiation is calculated taking account of exchange currents set up during impact. J. JACOBS

530.145

8528. On the theory of the passage of particles through a potential barrier. G. F. Drukarev. *J. Exp. Theor. Phys., USSR*, **21**, 59–68 (*Jan.*, 1951) *In Russian.*

The escape of particles from a region surrounded by a spherically symmetrical potential barrier is treated as a non-stationary problem. It is shown that if at $f = 0$ a particle is inside in one of the quasi-stationary states, then if the transmission coefficient is sufficiently large the time modulus of the wave function beyond the barrier increases exponentially with distance when $r < vt$, and falls rapidly for $r > vt$, and $\to 0$ as $r \to \infty$. In the general case of arbitrary initial state, the wave function beyond the barrier may be expressed as the sum of terms corresponding to the disintegration of different quasi-stationary states and of terms describing the spread of the wave packet. E. P. GEORGE

530.145

8529. On the theory of generalized wave-equations. G. Höhler. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 77–90 (1951) *In German.*

The Green's functions, the periodic spherically symmetric solutions and the "mass spectrum" associated with a classical linear wave equation are obtained, and their relation to particular cases already treated otherwise in the literature is discussed. R. H. DALITZ

530.145

8530. An example on classical field mechanics. G. Höhler. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 91–6 (1951) *In German.*

The difference equation proposed by Möglich and Rompe [*Z. Phys.*, **113** (*No.* 11–12) 740–50 (1939)] as a non-relativistic electron equation of motion incorporating the notion of a smallest time interval, is shown included, and is studied further, in the general scheme proposed by Bopp [Abstr. 1620(1946)]. R. H. DALITZ

530.145

8531. On fields that cannot be localized. I. M. A. Markov. *J. Exp. Theor. Phys., USSR*, **21**, 11–15 (*Jan.*, 1951) *In Russian.*

Forms of fields are examined which admit the existence of a wavefunction beyond the region of non-localizability. Within this region the wavefunction is lacking or becomes identically zero. J. JACOBS

530.145

8532. On the interpretation of the operators of positron theory. J. G. Valatin. *J. Phys. Radium*, **12**, 607–15 (*May*, 1951) *In French.*

Operators are constructed in a way that is independent of any particular matrix representation. Consideration of their transformation under charge-reversal leads to a symmetry theorem which includes Furry's theorem as a special case. J. R. MADDOX

530.145

8533. Graphical representation of the integral solution of Bloch's equations. Y. Ayant. *C.R. Acad. Sci., Paris*, **233**, 245–7 (*July* 16, 1951) *In French.*

530.145

8534. A numerical variational method. R. E. Meyerott, P. J. Luke, W. W. Clendenin and S. Geltman. Letter in *Phys. Rev.*, **83**, 846 (*Aug.* 15, 1951).

A contribution to the theory of relaxation methods in eigenvalue problems. The energy parameter used in the difference equations must equal that found from the Ritz integral. A procedure requiring the consistency of these two values is outlined. L. S. GODDARD

530.145.6

8535. Determination of the most general solution of the Schrödinger equation for a Coulomb-potential. H. Krupp. *Ber. Verh. Sächs. Akad. Wiss. Lpz., Math.-nat. Kl.*, **97** (*No.* 8) 28 *pp.* (1950) *In German.*

The solutions of the radial wave equation of the wave mechanical Kepler problem that satisfy the usual boundary conditions are well known. In

various physical problems other solutions are needed. Explicit definitions for the two solutions are chosen, and the solutions are tabulated numerically for certain sets of values of the parameters.

MATHEMATICAL REVIEWS

530.162

8536. On the dynamical behaviour of a canonical ensemble. L. J. F. Broer. *Physica*, **17**, 531–42 (*May*, 1951).

It is pointed out that one runs into difficulties when one tries to calculate the adiabatic change in a system on sufficiently slow variation of an external parameter by purely dynamical methods applied to a canonical ensemble. When the classical equations of motion are used the adiabatic change is obtained, but using quantum mechanics, a difference is found. Some possible starting points for an analysis of this result and its physical meaning are indicated. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.132

8537. On the cardinal points in plane kinematics. G. C. Steward. *Philos. Trans. A*, **244** (*No.* 875) 19–46 (1951).

Aims at establishing the existence of "cardinal points" analogous to those in geometrical optics in plane kinematics, and to examine some of their properties. In addition, various new curves and configurations are obtained, relating to the generation of the Burmester points, and similar points of higher orders; together with a generalization of certain kinematical results which have emerged, stage by stage, in the writings of Chebyshev, Burmester, Müller and others. A.

531.311

8538. Atwood's machine and the teaching of Newton's second law. I. L. Kofsky. *Amer. J. Phys.*, **19**, 354–6 (*Sept.*, 1951).

The use of Atwood's machine in illustrating the principles of the application of Newton's second law to a simple physical system, whose connected parts have both rotational and translational motion, is shown. A diagram which shows the forces acting on all the component masses is drawn, and this picture facilitates the setting-up of the appropriate $F = ma$ and $\tau = I\alpha$ equations. The moment of inertia of the pulley, the friction in its bearings, and the mass of the string are included in the accelerating system in a natural way. The observed acceleration of the hanging masses can be compared with that computed by this method. A.

MECHANICAL MEASUREMENTS 531.7

531.714 : 621.317.79

8539. Improvements in null indicator electromagnetic gauges. E. B. Brown. *J. Sci. Instrum.*, **28**, 272–4 (*Sept.*, 1951).

The conditions for elimination of errors due to mains fluctuations are discussed, and an improve form of null setter is described, which is in itself useful piece of laboratory equipment since it may b used as an a.c. potentiometer, having a small an nearly constant phase defect less than ½°. The nu setter was originally designed by the author for us as a counterbalance for a diaphragm operate moving coil gauge, but in this paper its application shown to an a.c. mains operated gauge for remo indication with magnification of small angula deflections.

531.717 : 534.321.9 : 621.317.39.082

8540. Metal wall thickness measurement from on side by the ultrasonic method. N. G. Branson *Elect. Engng, N.Y.*, **70**, 619–23 (*July*, 1951).

The thickness of the walls of metallic structur has been determined to an accuracy of about 3% b an ultrasonic resonance technique. The principle the method is the marked increase of anode current a variable frequency oscillator which occurs when th frequency with which it drives a quartz cryst transducer in contact with the metal is equal to th fundamental frequency or a harmonic of the wa generated in the thickness of the material. Althoug in some cases the change of anode current may be great as 100%, it can be quite small, and enhance sensitivity is achieved by frequency-modulating th oscillator over a small frequency increment. In th case audible pulses of current are produced in th anode circuit when the average frequency equals th of the thickness resonance and can be detected headphones. The highest frequency at which th crystal is driven must be below the natural frequen of the quartz plate. A. C. Whiff

531.

8541. A microphotometric area determinator. I Walker, Jr, and Q. Van Winkle. *Rev. S Instrum.*, **22**, 604–6 (*Aug.*, 1951).

The Knorr–Albers microphotometer has be modified to permit the application of the trapezoid rule to the measurement of the true areas of phot graphically recorded figures of irregular shape. The modifications include a vertical plate-elevati mechanism and a timer controlled by a cam a roller microswitch.

531.7

8542. The development of a vacuum torsion balan and its use to measure sorption in dielectrics. A. Day. *Rep. Brit. Elect. Res. Ass. Ref. L/T256*, 11 (1951).

The balance will weigh 10^{-7} g. The procedure calibration and of carrying out tests is describe together with an account of the factors affecting t accuracy of the measurements. Experimental resu for the sorption and desorption of unplasticiz polyvinyl chloride are compared with values obtain previously, and several results are given for po styrene, at 50°c at water vapour pressures of 9 4·6 and 2·8 mm Hg. The diffusion coefficients a calculated both at the beginning of the sorption a after a few minutes when the initial high rate sorption reaches a much lower value. It is suggest that surface adsorption may determine the shape the mass/time curve during the first few minutes the test.

531.756 : 621.317.49 : 532.14

A magnetic float method for determining the densities of solutions. *See Abstr.* 8544

MECHANICS OF FLUIDS 532

532.13 : 536.2

8543. A relationship between heat conductivity and viscosity of liquids. S. R. MOHANTY. Letter in *Nature, Lond.*, **168,** 42 (*July* 7, 1951).

Andrade's relation [*Phil. Mag.*, **17,** 497–511 (*Feb.*, 1934)] for the viscosity (η poise), and Osida's [*Proc. Phys. Math. Soc. Japan*, **21,** 353–6 (*June*, 1939)] for the heat conductivity (K cal) of a liquid are combined to give $MK/\eta = 6$ where M is the molecular weight. Calculated values of MK_{bp}/η_{bp} for 7 "normal" liquids, using Bridgman's and Macleod's values for K_{bp} and η_{bp} respectively, are tabulated and it is shown that MK_{bp}/η_{bp} is a constant of mean value 10·8. The suffix bp refers to the boiling-point. S. WEINTROUB

532.14 : 531.756 : 621.317.49

8544. A magnetic float method for determining the densities of solutions. D. A. MACINNES, M. O. DAYHOFF AND B. R. RAY. *Rev. Sci. Instrum.*, **22,** 642–6 (*Aug.*, 1951).

A method for determining the densities of liquids is described in which a float containing a magnet is utilized. The conditions under which the submerged float would remain poised are found by adding weights and by observing the effect of currents through a solenoid. The method may be adapted to the measurement of the densities of solutions at a series of increasing concentrations by forming the solutions directly in the vessel containing the float. A.

532.511 : 536.48

On two-formulations of hydro-dynamics, and the problem of liquid helium II. *See Abstr.* 8695

532.516

8545. On the asymptotic behaviour of viscous fluid flow at a great distance from a cylindrical body, with special reference to Filon's paradox. I. IMAI. *Proc. Roy. Soc. A*, **208,** 487–516 (*Sept.* 24, 1951).

The asymptotic behaviour of flow at a considerable distance from an arbitrary cylindrical obstacle immersed in an otherwise uniform flow of an incompressible viscous fluid is considered on the basis of the Navier–Stokes equations. Carrying out the Oseen type of successive approximation to the third stage, the expression for the stream function is exactly determined to the order of r^{-1}, where r is the distance from some fixed point in or near the cylinder. Then, by considering the conservation of linear and angular momenta of the fluid enclosed between the cylinder and a large contour, exact analytical formulae for the lift, drag and moment acting on the cylinder are obtained. Thus Filon's well-known paradoxical result that the moment of a cylinder immersed in a viscous flow comes out to be logarithmically infinite with increasing extent of the flow region is given a complete explanation, and the usefulness of the Oseen type of successive approximation in dealing with the Navier–Stokes equations is confirmed. A.

532.516

8546. Stability of viscous motion between parallel planes for finite disturbances. D. MEKSYN AND J. T. STUART. *Proc. Roy. Soc. A*, **208,** 517–26 (*Sept.* 24, 1951).

The linearized equation of motion and the equation of mean motion are solved simultaneously to find periodic solutions of finite amplitude. The expression U of the mean flow and the integrals ψ are interdependent; ψ, however, depends mainly on the value of U_0''/U_0' at the critical point. Accordingly, the linearized equation is solved for a set of values of U_0''/U_0'; for each case the critical point and corresponding critical Reynolds number are determined. These integrals, which are functions of U_0''/U_0', are inserted into the equation of mean motion; this leads to an equation between the amplitude of the vibration and the Reynolds number. To each Reynolds number there corresponds a definite value of the amplitude a. The actual profile differs slightly from the parabola; the second derivative, however, is considerably changed. A.

532.517.4

8547. On the fine-scale structure of turbulence. A. A. TOWNSEND, *Proc. Roy. Soc. A.*, **208,** 534–42 (*Sept.* 24, 1951).

Recent experimental measurements of the energy spectrum of turbulence at very large wave-numbers have shown that the motion represented by these wave-number components is determined by the kinematic viscosity and the total turbulent energy dissipation, although the range of wave-numbers responsible for the bulk of the viscous dissipation is far from the condition of absolute equilibrium postulated in the theory of local similarity. To account for this anomaly and for the observed spatial inhomogeneity of the motion, it is suggested that the motion is essentially a random distribution of vortex sheets and lines, in which the vorticity distribution is effectively stationary in time, due to balance between the opposing effects of vorticity diffusion by molecular viscosity, and vorticity production and convection by the turbulent shear. The spectrum functions due to stationary vorticity distributions in two types of shear field, viz. plane shear and axial extension, have been computed and compared with experiment. A better fit is obtained for plane shear, which produces a vortex sheet, than for axial extension, which leads to a vortex line, and there is some experimental evidence that conditions suitable for the production of vortex sheets are more common than for production of vortex lines. Finally, the implications of the validity of this hypothesis are considered in relation to the applicability of the Heisenberg form for the turbulent energy transfer. A.

532.517.4

8548. Discussion of the spectrum of turbulence. K. KUSUKAWA. Note in *J. Phys. Soc. Japan*, **6,** 206–7 (*May–June*, 1951).

A discrepancy between the expression for the spectrum of turbulence in the author's quantized

theory of turbulent flow [see Abstr. 6076 (1951)] and that occurring in the usual non-quantized theory [*Quart. Appl. Math.*, **6**, 97 (1948)] is attributed to the fact that the smallest volume-element of fluid is considered to be finite, and the effect of its spin to be comparable to other effects. While the fundamental equation of motion of a viscous fluid has an irreversible character, the modified equation of motion used to quantize the system is reversible in character, being a 2nd-order differential equation with respect to time. A phenomenon which can be quantized may reasonably be considered a reversible elementary process, and its irreversibility enters only into the discussion of its statistical character. The quantization of flow can be applied to phenomena which neither hydrodynamics nor the kinetic theory of molecular motion can discuss. J. S. G. THOMAS

532.522.2

8549. Propagation of transverse waves along eddy filaments. N. V. IVASHENKO. *J. Tech. Phys. USSR*, **21**, 413–16 (*April*, 1951) *In Russian.*

A special apparatus was designed for observing the setting up of eddies on the efflux of a liquid through an orifice and the interaction between eddy and surrounding liquid. The apparatus also permitted of measuring the pressure within the hollow eddy and the relation between pressure and intensity of the eddy, and of obtaining travelling and standing waves along the eddy. Examples of travelling, direct and reflected waves are shown in photographs and the relation between wavelength and eddy intensity may be taken from tabulated results. B. F. KRAUS

532.525 : 532.517.4

8550. Influence of the turbulence of a jet of liquid on its atomization. N. S. PANASENKOV. *J. Tech. Phys., USSR*, **21**, 160–6 (*Feb.*, 1951) *In Russian.*

532.525 : 541.182.2

8551. Droplet size distribution in sprays. R. A. MUGELE AND H. D. EVANS. *Industr. Engng Chem.*, **43**, 1317–24 (*June*, 1951).

General features of size distribution are reviewed for dispersed systems. The concepts of "mean diameter" and "distribution parameter" are clarified and generalized. Previous applied distribution equations (Rosin and Rammler, Nukiyama and Tanasawa, log-probability) are examined critically in regard to theoretical soundness and application to spray data. A new equation, called the upper-limit equation, is formulated and proposed as a standard for describing droplet size distributions in sprays. It is based on the differential equation of the Gaussian distribution, the distributed quantity being $y = \ln ax/(x_m - x)$ where a is a dimensionless parameter, x is droplet diameter and x_m is maximum stable diameter. The upper-limit equation is applied to a wide variety of experimental data on sprays and more limited results on other dispersoids. It is concluded that the new equation fits the available spray data accurately, calculates the mean diameters accurately, applies also to emulsions and aerosols when the mechanism of formation is not too different from that of sprays, and indicates the type of distribution function that may be derivable from the basic mechanism of dispersion, when this mechanism is better understoo For a mechanical spray, the relation of the paramete of the distribution equation to physical properties a design variables is indicated.

532.5

8552. Proof that Ertel's vorticity theorem holds average for any medium suffering no tangential acceler tion on the boundary. C. TRUESDELL. *Geofis. Pu Appl.*, **19**, 167–9 (*April–June*, 1951).

The Ertel vorticity theorem in its usual local for is not valid for viscous fluids. By a purely kin matical analysis it is shown, however, that the theore continues to hold in mean over any volume on who bounding surface the acceleration is wholly norma for an arbitrary continuous medium.

532.5

8553. Cavitation at surface roughnesses. K. I SHALNEV. *J. Tech. Phys., USSR*, **21**, 206–20 (*Fe* 1951) *In Russian.*

532.

8554. The theory of symmetrical gravity waves finite amplitude. I. T. V. DAVIES. *Proc. Roy. Soc. A* **208**, 475–86 (*Sept.* 24, 1951).

The two-dimensional problem of symmetric fini amplitude gravity waves in an incompressible fluid infinite depth is treated by a method which first i volves satisfying a non-linear boundary conditi exactly. The higher approximations are obtained the method of small parameters. The breaking-wa conditions are discussed and expressions are given the free-surface equation, the kinetic and the potent energies of the fluid.

532.

8555. The ray-particle analogy. C. ECKART. *Mar. Res.*, **9**, 139–44 (*Oct.*, 1950).

Rays in a two-dimensional wave field are sho to be identical with trajectories of a particle movi with total energy zero and potential energy $-1/$ where c is phase velocity of the waves, which m depend on frequency. This is the basis for a propos analogue method of ray-tracing for gravity waves water, namely, the rolling of a ball on a prope contoured surface. The most convenient case is shallow water where $c^2 = g \times$ depth; otherwise required surface depends on wave frequency.

APPLIED MECHANICS REVIE

CAPILLARITY 532.6

532.6 : 541.18

8556. Shatter of drops in streams of air. W. LANE. *Industr. Engng Chem.*, **43**, 1312–17 (*Ju* 1951).

Using electronic flash and spark photograp stages of the shatter of individual drops exposed steady and transient air streams were identified a interpreted in terms of fluid mechanics. The sec dary droplets into which a drop was shattered w found to be progressively smaller as the velocity

the air stream was increased, but at the highest (supersonic) velocities used, they were not so small as would be predicted by extrapolating the relationship established for breakup in a steady air flow. A.

532.61

8557. Note on surface tension and the theory of holes. R. L. CHOATE AND L. H. LUND. Letter in *J. Chem. Phys.*, **19**, 1062 (*Aug.*, 1951).

A semi-empirical formula for the calculation of surface tension is derived, based upon the energy associated with the formation of a hole. T. C. TOYE

532.64 : 532.612.3

8558. Contact angles and surface tensions in liquid/solid systems. G. A. H. ELTON. Letter in *J. Chem. Phys.*, **19**, 1066 (*Aug.*, 1951).

Antonoff's rule is applied tentatively to solid/liquid interfaces and the surface tension of the solid (saturated with liquid) calculated from the contact angle. Experimental results for paraffin wax using three different liquids lead to the values 27·0, 27·2, 27·3 dynes/cm, which are similar to the surface tensions of liquid hydrocarbons. J. IBALL

532.65 : 536.423.15 : 533.77

Vapour pressure of small droplets. *See Abstr.* 8586

532.696.1

8559. Method for determining the surface tension of solids. C. BENEDICKS. *C.R. Acad. Sci., Paris*, **233**, 409–10 (*July* 30, 1951) *In French.*

A method based on the negative wetting effect [Abstr. 7600 (1951)] enables the surface tension of solids to be evaluated. For six substances, this has been found to vary from 87 (sugar) to 227 dynes/cm (tempered steel) which agrees in order of magnitude with theoretical predictions and with the results of an experimental method applicable to amorphous bodies. The surface tension of solids increases regularly with the hardness in an accelerated fashion. A.

532.696.1

8560. Liquostriction of solids, a consequence of the wetting effect. C. BENEDICKS. *C.R. Acad. Sci., Paris*, **233**, 482–4 (*Aug.* 6, 1951) *In French.*

See preceding Abstr. Several hypotheses of the surface tension of condensed phases enable the wetting effect to be simply interpreted, and predict a reversible dilatation of solids under the influence of a wetting liquid. Experiment verifies the existence of this *liquostriction*, whose value is very small: $2{\cdot}5 - 10 \times 10^{6}$. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 535.43 : 537.531

Generalization of Born and Green's kinetic theory of fluids to apply to collections of particles of several different kinds. *See Abstr.* 8763

532.72

8561. Diffusion in media with variable properties. II. Diffusion coefficients which vary discontinuously with concentration. J. CRANK. *Trans Faraday Soc.*, **47**, 450–61 (*May*, 1951).

For previous parts see Abstr. 6804 (1949), 2235 (1950). Mathematical solutions are presented for diffusion in a semi-infinite sheet when the diffusion coefficient changes discontinuously from one constant value to another at one or two values of concentration. These solutions are used to calculate relative rates of absorption and desorption and to study the effect of initial regain on rate of absorption. A summary of the results of this and previous papers of the series indicates, for the first time, the characteristic features of a concentration-dependent diffusion system. Attention is drawn to the fact that in many penetrant-polymer systems the behaviour is markedly different from this, which suggests that in such systems the diffusion coefficient depends on some other factor as well as concentration. A.

532.72

8562. Diffusion through an interface. E. J. SCOTT, L. H. TUNG AND H. G. DRICKAMER. *J. Chem. Phys.*, **19**, 1075–8 (*Sept.*, 1951).

The diffusion equation has been solved for the case of two cells of finite length with an interface between the cells. The effect of an interfacial resistance to mass transfer has been considered. It is shown that the situation where there is equilibrium (no resistance) at the interface is a special case of the solution. Several important cases are considered numerically. A.

532.72 : 541.64

On the measurement of the constant of the diffusion of polymers. *See Abstr.* 9099

532.73 : 541.18

8563. Solubilization of water in non-polar solvents by cationic detergents. S. R. PALIT AND V. VENKATESWARLU. *Proc. Roy. Soc. A*, **208**, 542–51 (*Sept.* 24, 1951).

Solubilization of water in common organic solvents by fatty acid salts of long-chain (C_{12}—C_{18}) aliphatic primary amines was studied. It was found that, of all the salts from formate to palmitate and oleate, dodecylamine-*n*-butyrate and octadecylamine propionate solubilize most in xylene, the figure reaching about 29 molecules of H_2O/mole of soap. Additions of free amine enhanced solubilization, while free butyric acid decreased the intake. The viscosity and freezing-point measurements of the same systems indicated that the additive is most likely to form a complex with soap micelles, and that their solubilizing power is modified thereby. Freezing-point measurements of detergent solutions with and without the solubilized phase showed, surprisingly enough, that the dissolved water elevates the freezing-points considerably, showing that solubilized water acts as a binding agent between micelles and probably promotes micelle formation. The results are discussed and correlated on Winsor's theory of solubilization. A.

532.77

8564. A method of determining the geometrical dimensions of macromolecules in a solution. V. TSVETKOV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 465–8 (1951) *In Russian.*

The methods of determining the dimensions of

macromolecules hitherto known, i.e. investigation of the asymmetry of optical diffraction in the solution of a high-molecular substance, or of the hydrodynamical behaviour (viscosity), dynamical birefringence, diffusion or sedimentation rate in solutions, are all limited to solutions of substances of molecular weight $> 10^6$ and of highest purity, which makes them unsuitable for the majority of technically important elastomers and plastics. The author's contention is that the investigation of the hydrodynamical behaviour and the mobility of the molecules in a solution should form a reliable basis for a universal method of determining molecular dimensions, if the quantities to be determined by experiment are so selected that their combination permits of eliminating indeterminate parameters and requires a minimum of theoretical assumptions about the structure of the macromolecules. Such quantities are the constants of the progressive and rotatory diffusion, measured for molecules of the same specimen in the same solvent. These quantities are connected by relations independent of the particle structure. The author proves his proposition theoretically, and also that experimental measurements (for isobutylene dissolved in petrol) by birefringence agree with the results obtained by his own method, which also permits of determining the degree of polymerization.

B. F. KRAUS

532.77

8565. Ramification and geometrical dimensions of chain molecules in a solution. V. N. TSVETKOV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 6) 1123–6 (1951) *In Russian.*

In a previous paper (preceding Abstr.) the author presented an experimental method of determining the geometrical dimensions of macromolecules and showed that the quantity determined by the diffusion experiments in solutions was the r.m.s. value of the molecule radius. It is now found that this quantity depends essentially on the degree of ramification of the molecular structure. A structure in which the length of the branches is of the same order as the length of the fundamental chain is first considered, and its actual occurrence depends on the uniform probability of ramification all over the "older" branches. Starting with simplest molecule models, the formal statistical theory is built up without regard to any true physico-chemical mechanism of molecule formation. The results of this admittedly crude approximation are compared with a known ramified molecule, viz. butadien polymerized in the 1 : 2 position, where the vinyl groups form short branches and there is no contradiction to the results of the approximate theory.

B. F. KRAUS

532.77 : 536.75

8566. The entropy of aqueous solutes. R. E. POWELL AND W. M. LATIMER. *J. Chem. Phys.*, **19**, 1139–41 (*Sept.*, 1951).

The standard partial molal entropies of monatomic ions and of non-electrolytes in aqueous solution can be represented by the empirical expressions: for monatomic ions, $\bar{S}^0 = (3/2)R \ln M + 37 - 270Z/r_e$; for non-electrolytes, $\bar{S}^0 = S^{int} + (3/2)R \ln M + 10 - 0{\cdot}22V_M$. Z = absolute value of the charge on the ion, r_e = effective radius of the ion, V_M = molal volume. These expressions can be interpreted in terms of the smoothed-potential type of partition function for the system. A.

MECHANICS OF GASES 533

533.15

8567. On the thermal effect of diffusion. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belge. Cl. Sci.*, **37** (*No.* 4) 307–23 (1951) *In French.*

The reason for the disagreement between the author's theory of the thermal effect of diffusion in gases and that of Waldmann is examined. It is shown that the latter is not logical. F. E. HOARE

533.15

8568. Diffusion properties of gases. IV. The self-diffusion coefficients of nitrogen, oxygen and carbon dioxide. E. R. S. WINTER. *Trans Faraday Soc.*, **47**, 342–7 (*April*, 1951).

For Pt III, see Abstr. 3829 (1950). The diffusion rates have been measured, by mass spectrometer, of the molecules $N^{14}N^{15}$, $O^{16}O^{18}$, and $C^{12}O^{16}O^{18}$ into isotopically-normal N_2, O_2 and CO_2 respectively. Measurements have been performed at 0°C and 45°C. The diffusion coefficients are, for O and N, in good agreement with the predictions of the Chapman–Enskog kinetic theory of gases using the Lennard–Jones 12 : 6 model. The experimental results for CO_2 are a little higher than the theoretical figures. A.

533.15 : 539.217.5 : 541.183

8569. Mobility in a sorbed layer. I. The flow of gases and vapours through porous media. W. M. JONES. *Trans Faraday Soc.*, **47**, 381–92 (*April*, 1951).

Theoretical equations are derived for the surface flow of an ideal two-dimensional gas through (*a*) a hole in a plane sheet, (*b*) a long circular capillary, and (*c*) a porous material, the porous material being treated as a bundle of capillaries. The equations express the flow in terms of the dimensions of the capillaries, the concentration of surface molecules at the ends of the capillaries, the molecular weight of the gas, and the temperature. The surface flow is not affected by the presence of the vapour phase in the capillaries nor by the roughness of the surface, provided the end conditions and the dimensions of the capillaries remain unaltered. The equations will explain the results of Tomlinson and Flood on the flow of ether and ethyl chloride through porous graphite, when the conditions of the experiment are such that nearly a monolayer is sorbed on the graphite. At lower surface concentrations the effect of surface field must be taken into account, this is discussed. The results of Carman on the flow of sulphur dioxide through porous silica are also discussed and here the surface field appears to restrict surface mobility for all concentrations examined. It is concluded that in addition to the expressions for Poiseuille flow and Knudsen flow which occur in equations for the flow of gases and vapours through fine capillaries, a third expression must be included, namely, that for the

flow of sorbed molecules over the surface of the capillaries. A.

533.15 : 541.183.26

8570. Flow of gases and vapours in a porous medium and its bearing on adsorption problems. I. The steady state of flow. R. M. BARRER AND D. M. GROVE. *Trans Faraday Soc.*, **47**, 826–37 (*Aug.*, 1951).

A study has been made of the steady state of flow of He, Ne, A, Kr, H_2, O_2, N_2, NH_3, CCl_4 and SO_2 through a bed of small nearly spherical synthetic analcite crystals. Flow rates, permeabilities, Knudsen and Poiseuille contributions to permeability and permeability constants have been determined and used to test the applicability of several equations of flow. Significant deviations from the behaviour suggested by these equations have been observed, especially for vapours. Pore properties and total surfaces have been determined using procedures based on steady state flow data. A.

533.15 : 541.183.26

8571. Flow of gases and vapours in a porous medium and its bearing on adsorption problems. II. Transient flow. R. M. BARRER AND D. M. GROVE. *Trans Faraday Soc.*, **47**, 837–44 (*Aug.*, 1951).

By measuring the time-lag L in setting up the steady state of flow one may measure the diffusion coefficients of gases in a porous medium and obtain a mean pore radius and an internal surface of the porous medium independently of all steady state methods. In beds of analcite crystals the inert gases, permanent gases and CCl_4 behave as though they were not adsorbed appreciably at low pressures while ammonia and sulphur dioxide show strong adsorption effects. In very dilute adsorbed films of NH_3 and SO_2 surface diffusion, while not necessarily absent, is limited in extent. The lifetimes τ of molecules in the adsorbed states are then given by the equations: NH_3: $\tau = 3{\cdot}1\times10^{-11}\exp(4\,300/RT)$ sec. SO_2: $\tau = 6{\cdot}6\times10^{-11}\exp(3\,010/RT)$ sec. A.

533.15 : 545.7

8572. The effect of thermal diffusion on physicochemical measurements. E. WHALLEY. *Trans Faraday Soc.*, **47**, 815–26 (*Aug.*, 1951).

The effect of thermal diffusion on the measurement of equilibrium constants, etc., is discussed. The reduction of the error due to thermal diffusion by the addition of a heavier gas and by causing the gas to flow through the temperature gradient is considered. In adding a heavier gas the measurements for all but isotopic mixtures must be extrapolated to both infinite mass and unit mole fraction of the added gas to eliminate the thermal diffusion error. Equations are developed for calculating the concentration difference due to thermal diffusion in a non-isothermal flowing system. A.

533.16 : 536.24

8573. Simultaneous heat and mass transfer. T. [IZUSHINA AND M. NAKAJIMA. *Mem. Fac. Engng Kyoto Univ.*, **13**, 40–8 (*Jan.*, 1951).

From the analogies heat transfer and fluid friction, and mass transfer and fluid friction, relations between heat transfer and mass transfer are deduced. The equation $h/k' = (\phi/\sigma)^{1/2}c_p$ is shown to fit experimental data for water and several organic solvents obtained by means of a wet and dry bulb hygrometer (h = coeff. of heat transfer; k' = coeff. of mass transfer; ϕ = Schmidt number $\mu/\rho D$; σ = Prandtl number $c_p\mu/\lambda$. This equation is of use in the study of unit operations such as drying, humidification and dehumidification. E. H. DOCK

533.21 : 536.7

8574. Thermodynamical properties of argon as function of pressure and temperature between 0 and 2000 atmospheres and 0° and 150°C. A. MICHELS, R. J. LUNBECK AND G. J. WOLKERS. *Appl. Sci. Res.*, **A2** (*No.* 5–6) 345–50 (1951).

Tables are given for integral values of pressure up to 2 000 atmospheres and temperatures between 0° and 150°C. A.

533.5 : 531.788

8575. A novel method for the estimation of very low pressures. R. GOMER. Letter in *J. Chem. Phys.*, **19**, 1072–3 (*Aug.*, 1951).

Some zinc phthalocyanine is sublimed on to the W tip of a Müller field-emission electron microscope [see Abstr. 2768 (1950)]. The individual molecule of phthalocyanine appears on the screen of the microscope as a four-leaf clover pattern and attention is focused on this until some movement or fluctuation in brightness occurs, when counting is started and the time noted until the next change. From the average time taken and the calculated area of the molecule the no. of impacts per unit time per unit area may be calculated and hence the pressure in the microscope. A set of observations is given. S. WEINTROUB

533.5 : 531.788.6 : 536.23

On the conduction of heat in rarefied gases and its manometric application. *See Abstr.* 8679–80

533.5 : 531.788.7

8576. Calibration of ionization gauges for various gases at low pressures. S. WAGENER AND C. B. JOHNSON. *J. Sci. Instrum.*, **28**, 278 (*Sept.*, 1951).

Three different types of ionization gauges are calibrated by comparison with a Knudsen gauge. The calibration is undertaken in the pressure range between 5×10^{-6} and 2×10^{-4} mm of Hg and calibration values are given for H_2, N_2, O_2, CO, CO_2 and water vapour. A.

533.5 : 542.73

A system for handling gases without stopcock grease. *See Abstr.* 9103

533.6.01

8577. Application of the M^2-expansion method to compressible flow past an elliptic cylinder. M. KAWAGUCHI. *J. Phys. Soc. Japan*, **6**, 168–74 (*May–June*, 1951).

Imai has derived the velocity distribution of two-dimensional irrotational flow of a compressible fluid over the surface of an obstacle of arbitrary shape [*Rep. Aeronaut. Res. Inst. Tokyo Imp. Univ.*, *No.* 275, 1943]. The formula is developed as far as the fourth power of the Mach number, M, of the flow. The formula is now applied to the uniform flow of fluid past an elliptic cylinder at zero angle of attack, and

an analytic expression derived for the velocity distribution over the cylinder, correct to M^4. Numerical values are calculated for elliptic cylinders of thickness ratio, $t = 0{\cdot}1$ and $0{\cdot}5$. Imai's theory, using the method of conformed representation, is briefly outlined. J. S. G. THOMAS

533.6.01

8578. On the subsonic flow of a compressible fluid past a Rankine ovoid. H. HASHIMOTO. *J. Phys. Soc. Japan*, **6**, 175–8 (*May–June*, 1951).

Various methods have been used to solve the non-linear equations of steady two-dimensional, subsonic flow past obstacles; their application to cases of three-dimensional flow is difficult except for flows round a sphere or very slender obstacles. The Janzen–Rayleigh theory is now applied to the approximate treatment of the three-dimensional flow of compressible fluid past a thick Rankine ovoid, the equations of motion being expressed in terms of Stokes's stream function. A 1st-order correction is derived and applied to the known solution for an incompressible fluid. Numerical values of the velocity distribution on the surface of the ovoid are derived for three Mach numbers, $M = 0$, $0{\cdot}5$ and $0{\cdot}6$, and compared with results for a sphere for the same 3 values of M. The effect of compressibility on the velocity, Δq, is nearly the same for a Rankine ovoid of thickness ratio $0{\cdot}9$ as for a sphere.

J. S. G. THOMAS

533.6.011

8579. On the influence of acoustic relaxation on compressible flow. L. J. F. BROER. *Appl. Sci. Res.*, **A2** (*No.* 5–6) 447–68 (1951).

The equations of motion for a gas in which relaxation can occur are derived. Some general properties of their exact solutions are discussed. In particular it is shown that the relaxation effects a change in the characteristics of the equations, independent from the magnitude of the relaxation time. The equations for steady one-dimensional flow are solved. It is shown from these equations that shock-waves have a certain minimal total strength and that steady flow with a speed within the region of possible sound speeds is unstable. Finally some remarks on oblique shocks are made. A.

533.6.011.5

8580. Similarity laws of hypersonic flows. K. OSWATITSCH. *Z. angew. Math. Phys.*, **2** (*No.* 4) 249–64 (1951).

A flow is termed hypersonic when the free stream Mach number M_∞ becomes very large. On the body itself, however, the local Mach numbers can still be arbitrarily small. It appears that, the larger the product of free stream Mach number and thickness ratio compared with unity, the better the hypersonic flow condition is fulfilled, i.e. bluff bodies reach hypersonic conditions, with increasing M_∞, quicker than slender bodies. The hypersonic flow pattern is determined essentially by the boundary conditions along the head wave. From considerations of this hypersonic shock it appears that the whole flow pattern of head wave, streamlines and Mach lines, as well as the pressure coefficient, for bodies of arbitrary form and thickness are independent of M_∞. Further, the pressure coefficient on the surface of slender bodies increases with the square of the thickness; the flow in longitudinal sections of flat bodies can be regarded as two-dimensional and the lift increases mainly with the square of the incidence. A

533.6.011.5 : 534.222.2

8581. On the theory of shock waves produced by a rigid wedge moving through an elastic medium with supersonic velocities. K. KUSUKAWA. *J. Phys. Soc. Japan*, **6**, 163–5 (*May–June*, 1951).

Using linearized equations appropriate to the condition of small strain, formal solutions are found for the field of flow around a wedge moving with supersonic velocity. Two special cases are considered: (*a*) irrotational flow and (*b*) flow of a deformable incompressible fluid. It is shown that the formal solution for case (*a*) implies that η the coeff. of friction between the fluid and the wedge is defined by $\eta = \mu \sin(2\alpha - \gamma)/[\lambda + \mu \cos 2(\alpha - \gamma)]$ where α is the semi-angle of the shock wave attached to the apex of a wedge of semi-angle γ; λ and μ are Lamé's constants. Such a solution is physically possible because $0 < \eta < \mu/(\lambda + \mu) < 1$. A formal solution is possible in case (*b*), but as it implies a shearing force acting in the direction of the velocity of flow it is physically unrealizable. A numerical solution for $\gamma = 5°$ is given; it is found that in this case the min. difference in transverse strain across the shock front occurs at Mach no. $M = 1{\cdot}36$. A. SCHOFIELD

533.6.011.5 : 534.222.2

8582. On the theory of shock waves produced by a rigid cone moving through an elastic medium with supersonic velocities. K. KUSUKAWA. *J. Phys. Soc. Japan*, **6**, 166–7 (*May–June*, 1951).

The field of flow around a slender conical obstacle is calculated by a method similar to that used for a wedge [preceding Abstr.]. Values of the strain at the wall of a cone of semi-angle 5° are tabulated for Mach no. $M = 1{\cdot}06$ to $M = 2{\cdot}92$. A. SCHOFIELD

533.6.08 : 532.517.2

8583. On the construction of hot-wire anemometers for the investigation of turbulence. B. G. VAN DE HEGGE ZIJNEN. *Appl. Sci. Res.*, **A2** (*No.* 5–6) 351–61 (1951).

A description is given of the construction of a hot-wire anemometer for the investigation of turbulence and of the method of spot welding tungsten wire to the supports of this anemometer. This description is preceded by a review of the requirements which have to be satisfied; the principal dimensions of the "Delft" anemometer: wire length, wire diameter and the dimensions of the supports follow from these requirements. It seems that the wire length should for the present purpose not exceed $0{\cdot}5$ mm and that the wire diameter should be $0{\cdot}005$ mm or less.

MOLECULAR THEORY OF GASES 533.7

533.7 : 536.7

8584. Determination of intermolecular forces from the equation of state of gases. II. T. KIHARA. *J. Phys. Soc. Japan*, **6**, 184–8 (*May–June*, 1951).

For Pt I, see Abstr. 5599 (1950). The second and

third virial coefficients are calculated for a "square well" potential and Lennard–Jones potential and compared with experiment. The first method represents the observed temperature variation fairly well, but the second with $n = 12$ gives values for the third coefficient which are too small. Better agreement is obtained with $n = 9$ although this would probably not be satisfactory if other properties were considered.

F. E. HOARE

533.72

8585. Molecular energy at high pressure. T. L. COTTRELL. *Trans Faraday Soc.*, **47**, 337–42 (*April*, 1951).

The effect of molecular interaction at high pressure has been discussed using the approximation that a molecule enclosed by its neighbours may be considered to be in a box with an infinitely steep potential wall. The calculation has been carried out by the variation method for the H_2 molecule-ion in a spheroidal box, and the results have been compared with earlier calculations on the H atom in a spherical box, with a cruder calculation for diatomic molecules, and with experimental results on other gases. The approximation apparently gives results of the correct order of magnitude, but tends to exaggerate the effect of pressure. A.

533.77 : 532.65 : 536.423.15

8586. On the vapour pressure of small droplets. F. KUHRT. Note in *Naturwissenschaften*, **38** (*No.* 12) 281 (1951) *In German.*

Theoretical. It is shown that the statistical mechanical relation $ln(p_\nu/p_\infty) = (2\sigma 0_\nu)/3kT\nu - 4/\nu$ for the vapour pressure p_ν of a free droplet consisting of ν molecules, where O_ν is the surface area, p_∞ the saturated vapour pressure of the liquid and σ the surface tension, can be derived by a cyclic process similar to that used to derive the Thomson–Gibbs equation. S. WEINTROUB

VIBRATIONS . ACOUSTICS 534

534.01

8587. Mathematical formulation of the problem of enforced harmonic oscillations in an arbitrary domain. G. D. MALYUZHINETS. *Dokl. Akad. Nauk, SSSR*, **78**, (*No.* 3) 439–42 (1951) *In Russian.*

The formulation of the problem of enforced harmonic oscillations supported by a source in a certain region is based on the principles of radiation and absorption, the first of which implies that the field at an infinite distance has the character of outgoing waves, and the second, that losses in the medium lead to field suppression. These two principles in their general form have serious disadvantages for the purpose in mind, which for the second principle are removed by Fock's method, used in his papers on theory of diffraction. This method consists in solving a boundary problem of the equation $\Delta u + k^2 u = F$ at first for a purely imaginary value of the parameter k, and then finding the analytical continuation of k in the complex plane to the required, e.g. real, value of the parameter. On this principle it is only necessary to find the corresponding Green function, to formulate the problem of the enforced oscillations excited by a single source. This is done in the paper for a scalar wave field, and the uniqueness theorem is proved. B. F. KRAUS

534.1 : 534.372 : 530.162

8588. Attempt at a non-vibrating table for recording the Brownian movement of a galvanometer. P. B. ROTTIER AND M. T. JANSEN. *Physica*, **17**, 603–11 (*June*, 1951) *In French.*

A table weighing 2 600 kg was mounted on rubber blocks with a period of oscillation of about 2 c/s. The Brownian movement of a galvanometer amplified by a thermo-relay, could be recorded without interference from external vibrations. A.

534.132

8589. Resonant vibrations in a water-filled piping system. D. B. CALLAWAY, F. G. TYZZER AND H. C. HARDY. *J. Acoust. Soc. Amer.*, **23**, 550–3 (*Sept.*, 1951).

The mechanism by which noise is transmitted in liquid-field piping systems was studied by tests on a straight free-free 2-inch pipe 53 ft long. The vibrations of the system below 1 000 c/s were characterized by high Q resonant modes consisting of longitudinal vibrations in the water, and both longitudinal and flexural vibrations in the pipe wall. Attenuation for all types of vibrations was very low, ranging from 0·001 to 0·09 db/ft. Large coupling between water vibrations and flexural pipe-wall vibrations was found to exist, so that longitudinal excitation of the water column resulted in flexural pipe-wall vibrations of large amplitude. Because of the large number of high Q modes in a practical piping system, it appears that the modes are the means of transmission of noise. The flexural modes are more numerous than other modes at low frequencies and are also important because of their coupling to radiating surfaces. A.

534.152 : 535.417

8590. Measurement of the amplitude of vibration of piezoelectric crystals by an interference method. L. N. BORODOVSKAYA AND A. E. SALOMONOVICH. *J. Tech. Phys., USSR*, **21**, 221–4 (*Feb.*, 1951) *In Russian.*

A Zeiss interference comparator was used for measuring the amplitude of the vibration of quartz crystals along the Y axis for frequencies of 75–160 kc/s. This comparator was a Michelson interferometer in which one of the mirrors served as the fixed polished surface of a wedge, the other polished surface of the wedge being the face of the quartz crystal under investigation; the wedge between the two surfaces was air filled. The wedge interference pattern obtained was viewed through an eyepiece fitted with a camera for photographing the pattern. Using this apparatus it was possible to graduate a control apparatus in absolute units in terms of the mechanical displacement of the faces of the piezo quartz crystal, and to establish a linear relation between the applied voltage

and the mechanical displacement. The relation between the normal and tangential displacement of any face of the crystal could also be established.

W. HUGHES

534.21

8591. On the propagation of energy in linear conservative waves. L. J. F. BROER. *Appl. Sci. Res.*, A2 (*No.* 5–6) 329–44 (1951).

This paper is concerned with the question when and why the rate of energy propagation in a system of waves equals the group velocity. It is shown by the method of stationary phase that this equality holds, for travelling waves without dissipation, whenever this method applies. The reason why this result can be obtained by this kinematical method is investigated by a discussion of simple harmonic waves. It is shown that the choice of an expression for the energy density to be used in connection with a given wave equation is restricted by the conservation of energy in such a way that the average rate of work done divided by the average energy density always equals the group velocity. Finally some examples of wave motion are discussed to illustrate the derived formulae.

A.

534.21

8592. Acoustic wave propagation along a constant normal impedance boundary. R. B. LAWHEAD AND I. RUDNICK. *J. Acoust. Soc. Amer.*, **23**, 546–9 (*Sept.*, 1951).

An expression is obtained for the amplitude and phase of an acoustic wave above a boundary due to a point source on or near a boundary which exhibits a constant normal specific acoustic impedance. This is shown to be a special case of the solution for an isotropic medium with constant characteristic acoustic impedance; specifically, the case is one in which the ratio of the propagation constant in the upper medium to that in the lower approaches 0. A material which obeyed a constant normal impedance boundary condition was constructed from ordinary drinking straws. Measurements of amplitude and phase as a function of receiver position along and above the boundary showed good agreement with theory. The nature of the approximations involved in the solution are discussed and it is shown to be an adequate representation of the sound field for distances greater than one wavelength from the source.

534.21

8593. Measurements on an acoustic wave propagated along a boundary. R. B. LAWHEAD AND I. RUDNICK. *J. Acoust. Soc. Amer.*, **23**, 541–5 (*Sept.*, 1951).

The sound field of a point source located at a plane boundary was measured both with respect to its amplitude and phase characteristics. This was done for a very high impedance boundary and one composed of material which is relatively absorbing. The fields were calculated, the calculations for the latter material being based on measured values of impedance and propagation constant, and found to be in good agreement with those measured.

A.

534.222.1 : 551.463

8594. The effect of temperature inhomogeneities in the ocean on the propagation of sound. L. LIEBERMANN. *J. Acoust. Soc. Amer.*, **23**, 563–70 (*Sept.*, 1951).

Horizontal small-scale temperature inhomogeneities in the ocean have been measured with the aid of a highly sensitive, rapid-response thermometer mounted on a submarine. The mean size of these inhomogeneities is of the order of 60 cm; a typical average temperature variation is 0·05°C. The physical features of the inhomogeneities which determine acoustical effects are shown to be described by the autocorrelation function; a specially constructed computing machine was used to calculate this function from the temperature records. The calculated backward scattering (reverberation) resulting from these inhomogeneities is given as a function of frequency. In the region 10 to 100 kc/s the calculated scattering is, in general, less than that which is actually observed in the ocean, suggesting that biological material is the major source of scattering in the ocean. A calculation of the attenuation of transmitted sound in the ocean resulting from scattering shows that this effect is small compared with absorption at the higher frequencies. Refractive effects of the inhomogeneities result in another acoustical phenomenon: local warping of the wave fronts produces intensity enhancement or diminution at the receiver. These effects quantitatively explain rapid acoustic fluctuations (scintillations) which are observed in the ocean.

A.

534.23

8595. Ultrasonic absorption in organic liquids. G. S. VERMA. *Proc. Nat. Acad. Sci. India, Sect. A*, **19** (*Pt I*) 34–44 (1950).

A crystal-controlled Pierce oscillator is used to measure the velocity of sound and the absorption coefficients at frequencies of 1·46 and 4 Mc/s in several organic liquids. The liquids are divided into 4 groups depending on the value of the absorption coefficient and an explanation of the differences is offered in terms of the hole theory of viscosity. In the case of acetic acid, the absorption is not proportional to the square of the frequency and there is an anomalous temperature effect. See Abstr. 2369 (1941).

H. J. H. STARKS

534.231.2

8596. Absorption characteristics of acoustic material with perforated facings. U. INGÅRD AND R. H. BOLT. *J. Acoust. Soc. Amer.*, **23**, 533–40 (*Sept.*, 1951).

This paper extends and unifies the analysis of sound absorptive structures consisting of (1) a layer of porous material separated from (2) a rigid wall by (3) an air cavity, which may or may not contain (4) separating partitions; and the porous material may or may not be covered with (5) a perforated facing. The normal impedance of the porous layer is expressed in a series form in which the first term suffices for a very thin layer. Equations and design charts are given for the impedance and the absorption coefficient, as functions of angle of incidence, for the complete structure with and without partitions. The statistical coefficient, averaged over angle, is plotted for each case over the commonly encountered ranges of all design variables. Calculated coefficients for eight different designs are compared with those measured

by the reverberation method and found to be in good agreement. A.

534.231.3

8597. A free field method of measuring the absorption coefficient of acoustic materials. U. INGÅRD AND R. H. BOLT. *J. Acoust. Soc. Amer.*, **23** 509–16 (*Sept.*, 1951).

A free field method is reported for the measurement of the normal impedance and the absorption coefficient of a material. The pressure and phase of an incident "plane" wave in steady state are measured at a point in the absorptive surface and compared with the pressure and phase measured at the same point in space at the surface of a perfectly reflecting material, or at the same point in free space without any panel. From these data are determined the phase and magnitude of both the incident and reflected waves, and this information in turn yields both the normal impedance and the free wave absorption coefficient for the particular angle of incidence involved. Tests have been made with an 8-ft square sample of material mounted in an anechoic chamber and rotated about a vertical axis in the presence of a fixed horizontal beam of an approximately plane wave. As a check of the validity of the method, measurements have been made using two types of material with known properties, one with the normal impedance essentially independent of the angle of incidence and the other with a considerable angular dependence. The experimental values are shown to be in good agreement with calculations. A.

534.231.3

8598. On the generalization of the concept of impedance in acoustics. O. K. MAWARDI. *J. Acoust. Soc. Amer.*, **23**, 571–6 (*Sept.*, 1951).

The conventional definitions of acoustical impedances so useful in the investigations of the properties of idealized systems with lumped parameters fail when applied indiscriminately to systems with distributed constants. In general, the present definitions are valid only when the specific impedance is constant on a wave front. By extending the notion of vector fields to specific impedances the previous restriction is removed and the scope of application is considerably increased. A definition for the acoustic impedance, based on energy concepts, is also proposed. A.

534.232 : 578.088.2

8599. Vibrating plate transducers for frequency studies of the breakdown rate of biological cells. E. ACKERMAN. *Rev. Sci. Instrum.*, **22**, 649–51 (*Aug.*, 1951).

Transducers are described giving audio outputs $> 0{\cdot}1$ W/cm^2, sufficient for cellular disruption. A method of measuring the spatial average of the transducer velocity amplitude is discussed. The apparatus is suitable for studies of the effect of frequency and velocity amplitude on the breakdown rate of biological cells. A.

534.26

8600. Experimental investigation of the diffraction in the focus of acoustic lenses. B. D. TARTAKOVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 6) 1119–22 (1951) *In Russian.*

Theoretical treatment of the characteristics of acoustical lenses used in supersonics is difficult and yields only rough approximations, because it is mainly based on theory of optical lenses and the difficulties arise in the diffraction structure of the focus. A century of experimental investigations of acoustical lenses only brought qualitative knowledge, because the measuring methods were too primitive. The author experimented with a lens displaceable in 3 directions in water. Readings were exact to $\frac{1}{20}$ of the shortest wavelength. The instrument was a piezo-electric hydrophon. The voltage produced by the crystal was amplified, converted into acoustical frequencies and fed to an automatic recording instrument with amplitude recording on a linear or logarithmic scale. The sound field was produced by a piezo-electric radiator excited by a stabilized generator. Only solid acoustic lenses of $n < 1$ were investigated. They were of metal, silicates, wood and plastics (Plexiglass) and marble. The results prove that plane, convergent and divergent sound fields of good definition may be produced by solid acoustic lenses.

B. F. KRAUS

534.321.9 : 532.7 : 577.3

8601. Cavitation and haemolysis by ultrasonics of different frequency. A. DOGNON AND Y. SIMONOT. *C.R. Acad. Sci., Paris*, **232**, 2411–13 (*June* 25, 1951) *In French.*

Direct measurements are made of the energy just necessary to produce haemolysis in human blood suspensions of different concentration by ultrasonic frequencies of 576, 960 and 1 440 kc/s. At infinite dilution, as would be expected, cavitation appears at an acoustic pressure proportional to frequency: up to a certain concentration the threshold of cavitation does not change, but for greater concentrations the acoustic pressure must be increased, particularly at the higher frequencies, to cause cavitation and haemolysis. At 1 440 kc/s, haemolysis could not be produced when the red corpuscle concentration exceeded 0·65 per cent by volume. See Abstr. 7630 (1951). H. J. H. STARKS

534.37 : 534.844

8602. The discontinuous growth and decay of sound in a one-dimensional room. H. B. MILLER. *J. Acoust. Soc. Amer.*, **23**, 517–30 (*Sept.*, 1951).

The growth and decay of sound in a one-dimensional room was investigated by using a very special room, namely, a helical spring. Compressional waves in the audio frequency range were sent down the spring by an electromechanical driver and received at the far end by an electromechanical pick-up. Reflection occurred at each terminal, allowing standing waves to be built up. The length of the spring was 30 in and the transit time was 53·6 milliseconds, giving a propagation velocity of about 46½ ft/sec. The 30 in spring is thus equivalent to a room about 58 ft long. Oscillograms were obtained for frequencies below 100 c/s, showing the discontinuous nature of the reverberation produced in the one-dimensional room. During the analysis of the oscillograms, Erying's

mechanism of image sources was found to fail to explain some of the oscillograms. A new mechanism was therefore created, called the Two-Pipe Mechanism, which seems to explain all the oscillograms. This clarifies: (1) the behaviour of a normal mode when decay is started before steady state has been reached; (2) the growth and decay of standing waves on a violin string, by demonstrating the quantized envelope-levels which control this growth and decay; (3) the growth and decay of non-normal modes, by showing how decay can consist of the steady-state frequency alone, even though this is a "not-allowed" frequency. A.

534.6 : 621.317.74 : 621.395.92

8603. Measurements on hearing aids. F. MÜLLER. *Funk u. Ton*, **5**, 361–8 (*July*, 1951) *In German.*

The factors for consideration in the evaluation of a hearing aid are tabulated. The most important, measurement of overall sound and pressure amplification, is selected for study. The generally accepted test set-up is as follows:—the hearing aid is placed so as to receive sound under "free space" conditions from a tone generator and loudspeaker. The earpiece of the aid is coupled through an artificial ear to a microphone, its amplifier, and a voltmeter, thereby enabling the sound output from the aid to be determined. A microphone, amplifier and voltmeter, preferably the same, are then used to measure the sound pressure at the position previously occupied by the hearing aid microphone. As true "free space" conditions are expensive to achieve, a cheaper and almost equally accurate arrangement is recommended instead. The loudspeaker output is fed into a tube at the far end of which is a pressure chamber. In here two microphones can be arranged symmetrically and used for the test described above, but in a modified form. Regarding output conditions, two designs of artificial ears are described in detail and their dimensions given. The overall accuracy required is ± 1% for frequency and ± 1·5–3·0 db for gain. A recommended scale for showing frequency characteristics is specified. H. G. M. SPRATT (R)

534.64

8604. Measurement of acoustic impedance. S. B. L. SRIVASTAVA. *Proc. Nat. Acad. Sci. India, Sect. A*, **15** (*Pt IV*) 136–42 (1946).

Describes a simple method of measuring acoustic impedance (for commercial purposes) of materials like felt and "celotex." The method employs a stationary wave system set up by interference between incident and reflected waves—the apparatus being adapted to measure the absorption coefficient and phase change at reflection—whence the acoustic impedance of the material is deduced. A. B. WOOD

534.844.1

8605. Ultra speed recording for acoustical measurement. C. J. LEBEL AND J. Y. DUNBAR. *J. Acoust. Soc. Amer.*, **23**, 559–63 (*Sept.*, 1951).

The technique and tests described were devised to study possible improvement in rating the acoustical excellence of rooms, by using higher pen speeds than had hitherto been available. Recordings of reverberation decay characteristics, made with the new ultra speed technique, are compared with results from older methods of recording reverberation; and it is found that the new method provides a much more adequate diagnosis of recognized acoustical faults. The new technique makes possible ink recording of acoustical levels on a db basis at pen speeds of 5 000 to 10 000 db per second, or ten to twenty times that afforded by the high speed level recorder. It uses a new stabilized logarithmic Varistor system for instantaneous conversion to a db basis, followed by a direct writing oscillograph. Hitherto unrecognized requirements for the electronic system are indicated as necessary if adequate stability, linearity and scale range are to be achieved. A.

534.845.2

8606. The absorption coefficients of fir plywood panels. R. W. KENWORTHY AND T. D. BURNAM. *J. Acoust. Soc. Amer.*, **23**, 531–2 (*Sept.*, 1951).

The absorption coefficients of flat, splayed and cylindrical panel assemblies made from one-quarter-inch three-ply fir plywood have been measured by the reverberation chamber method under three different conditions. All panels have greater absorption at the lower frequencies (128 and 256) than at higher frequencies. The effective absorption of each type can be increased by using a half-inch kapok felt in combination with it, either mounted on the wall behind the panel or spot-cemented to the plywood. Each type of panel has desirable characteristics under certain conditions. The absorption of all types indicates that such panels are important acoustical materials in the lower frequency range. A.

OPTICS . RADIATION . SPECTRA 535

535.215 : 522.615 : 778.3

8607. An ideal photon receiver. Preliminary results. A. LALLEMAND AND M. DUCHESNE. *C.R. Acad. Sci., Paris*, **233**, 305–7 (*July* 23, 1951) *In French.*

The image of an object is formed on a photocathode. The electrons thus liberated are accelerated (20 to 40 kV) and an electronic image of the photocathode is formed on a photographic plate which will register the image. Objects which are so weakly illuminated that it takes 6 hours to form a photographic image, will be registered in much greater detail by the electronic method in 4 min. This method is specially applicable to astronomic photography. W. SUMMER

535.22

8608. Velocity of light. U. STILLE. *Phys. Bl., No.* 6, 260–4 (1951) *In German.*

Recent determinations are discussed and weighted for an estimation of the most probable value. The result is (299 790 ± 6) km/sec. L. ESSEN

535.225

8609. Reflection of light from two parallel moving mirrors. J. SIVADJIAN. *Rev. Opt. (Théor. Instrum.)* **30**, 323–31 (*July*, 1951) *In French.*

Previous theories of the reflection of light from moving mirrors are examined and, in particular, the

asic assumptions of the Lorentz explanation of the Michelson–Morley experiment are criticized. Reflection at the semi-silvered mirror is shown not to occur exactly at 45° and the path of the ray is not that previously assumed. 44 references are given.

R. W. FISH

535.241

8610. A graphical method for solving problems of low-level photometry. W. DE GROOT. *Appl. Sci. Res.*, **B2** (*No.* 2) 131–48 (1951).

A certain level of subjective brightness may be characterized by the minimum power per unit area and solid angle, E_m, with which the corresponding brightness impression can be evoked monochromatically, the corresponding wavelength being λ_m. If the visibility function $V(\lambda_m, \lambda)$ for that level of subjective brightness is known, it is possible to find the luminance $L_E = K\int E(\lambda)V_p(\lambda)d\lambda$ of a radiation $E(\lambda)$ for which $\int E(\lambda)V(\lambda_m, \lambda)d\lambda = E_m$, giving the same brightness impression as E_m. This is achieved by a graphical method which can be incorporated in a slide rule for low-level photometry. Luminance scales for different relative energy distributions are easily obtained and, after choosing one of them as a standard of subjective brightness, other luminances may be corrected according to the standard scale chosen. Luminances for monochromatic radiations of wavelength λ may be obtained in the same way. When plotting these $v.\ \lambda$ for a number of values of E_m one obtains Bouma's diagram in which the data for composite radiations may be also drawn. An analysis is given of Weaver's data regarding $V(\lambda_m, \lambda)$ [Abstr. 3068 (1949)] and the various functions discussed in the preceding sections are calculated using these data. Finally the function $V_2(\lambda_m)$, as obtained from these calculations, is checked with other data from literature. A.

535.247.4

8611. An accurate electronic whitenessmeter. L. H. VAN DER TWEEL. *Appl. Sci. Res.*, **B2** (*No.* 1) 53–60 (1951).

A rigid and fast-acting photoelectric whitenessmeter is described. By varying the cathode resistance of an amplifier tube the use of precise optical measuring devices is avoided. An averaging mechanism is included. The accuracy for non-rotating samples is of the order of 0·1%. A.

535.317.23

8612. Spurious resolution of photographic lenses. J. N. HOTCHKISS, F. E. WASHER AND F. W. ROSEBERRY. *J. Opt. Soc. Amer.*, **41**, 600–3 (*Sept.*, 1951).

In the course of some preliminary experiments on a new type of resolving power target the phenomenon of spurious resolution has been encountered. It is shown that this false resolution can be explained by a geometrical analysis without recourse to diffraction theory. The intensity distribution in the out-of-focus image of a point source is calculated from spherical aberration data and is integrated over the target by the method of Schade. Representative exposures and microphotometer traces are included. It is pointed out that the plane of best contrast rendition is not necessarily the plane of best resolution. It is demonstrated that counting the number of lines in the image of a multiline target will not always detect spurious resolution. A.

535.317.6

8613. Optical calculations with automatic computing machinery. D. P. FEDER. *J. Opt. Soc. Amer.*, **41**, 630–5 (*Sept.*, 1951).

The National Bureau of Standards has been making optical calculations using both the high-speed SEAC and the commercially available IBM Card Programmed Electronic Calculator. Formulae especially suitable for machine computation are presented here. These enable a general ray to be traced through a rotationally symmetrical system of spherical or non-spherical surfaces. Formulae are also given for computing first- and third-order coefficients for any centred optical system. The formulae are derived from well-known forms, but they are transformed so that none of the quantities used in the machine ever becomes indeterminate or infinite. The formulae for first- and third-order coefficients are simpler than those frequently given and are very convenient for hand calculation. A.

535.317.6

8614. Ray tracing using the IBM Card Programmed Electronic Calculator. W. A. ALLEN AND R. H. STARK. *J. Opt. Soc. Amer.*, **41**, 636–40 (*Sept.*, 1951).

The standard ray tracing equations can be adapted easily for machine use. The mathematical treatment is algebraic rather than trigonometric. Examples of meridional and skew ray tracing are given. A satisfactory lens has been calculated and tested entirely by machine methods. The machine is expected to be of value in the refining of optical systems, in the determination of optical shop tolerances, and in the investigation of existing prescriptions. A.

535.33.03 : 531.71 : 621.327.42

8615. Isotope electric discharge lamps as spectral sources for the exact measurement of length. R. D. KNOTT. *G.E.C. J.*, **18**, 169–75 (*July*, 1951).

Describes the way in which Hg 198 is made and the factors which affect the sharpness of the spectral lines given by such an isotope. The form of lamp found most suitable for interferometry is a water-cooled cold cathode lamp with large hollow Mo cylinders as electrodes and A at 10 mm pressure as carrier gas. Lengths up to 20 cm, corresponding to an order of interference of about 350 000, can be measured with such a source. To obtain higher source intensities and minimum line width a water-cooled electrodeless lamp has been developed. Future work includes the development of a Kr 84 lamp, cooled in liquid air to reduce the Doppler broadening effect on the lines.

J. W. T. WALSH (R)

535.33.03 : 535.89

8616. An incandescent tungsten source for infrared spectroscopy. J. H. TAYLOR, C. S. RUPERT AND J. STRONG. *J. Opt. Soc. Amer.*, **41**, 626–9 (*Sept.*, 1951).

The carbon arc furnishes the brightest source of infrared readily obtainable, but the interfering absorption spectra of atmospheric CO_2 and H_2O are difficult to avoid when using it. An infrared source is described, consisting of a tungsten ribbon formed in the shape of a cavity, and heated electrically to

2 900°K, in an inert atmosphere. The power required is 390 W. Such a source furnishes a signal 2–4 × that of the conventional Globar over the rock-salt spectral region. While only about half as bright as the carbon arc, it can be used with an optical path free of atmospheric absorption. A.

535.33.07

8617. The influence of the slit width of the spectrograph on the distribution of energy in the continuous spectrum. II. B. Righini Crinò. *Ann. Astrophys.*, **14** (*No.* 2) 221–31 (1951) *In French.*

For Pt I, see Abstr. 6837 (1951). The effect on the spectrum energy distribution of diffraction by the slit when illuminated by an image of the source formed by a condenser, is shown to be the same as that found for the case of direct illumination by an extended source (see previous part) for all slit widths considered. D. L. EDWARDS

535.33.07

8618. The influence of slit-width on the shape and intensity of infra-red absorption bands. J. B. Willis. *Aust. J. Sci. Res. A*, **4,** 172–80 (*June*, 1951).

Making certain assumptions as to the shape of infrared absorption bands and the shape of the slit function of the monochromator, expressions are obtained for the dependence on spectrometer slit-width of the intensity and half-width of absorption bands. Experimental data to confirm the accuracy of these deductions are presented. A.

535.33.07

8619. Concave grating spectrograph with grazing incidence in vacuum for the far ultra-violet. N. Astoin. Letter in *J. Phys. Radium*, **12,** 695–6 (*June*, 1951) *In French.*

An equipment for use between 80 and 1 390 Å.

S. T. HENDERSON

535.33.07

8620. Note on optimum transmittance in spectrophotometry. D. Z. Robinson and R. Cole. Letter in *J. Opt. Soc. Amer.*, **41,** 560 (*Aug.*, 1951).

A value is calculated by developing methods of earlier papers [Abstr. 4232 (1951) and *Analyt. Chem.*, **23,** 273 (1951)] assuming equal errors in 100%, zero and specimen readings. G. F. LOTHIAN

535.33.07 : 518.5

8621. Electronic computation of wave numbers. G. K. Werner, J. R. McNally, Jr and P. C. Johnson. Letter in *J. Opt. Soc. Amer.*, **41,** 559–60 (*Aug.*, 1951).

A simple 2-step process yielding 3 000 wave numbers per hour as compared with 250 per hour using Kayser's tables. A. J. KENNEDY

535.33.072 : 541.127

Rapid and sensitive spectro-photometry. *See Abstr.* 9053–5

535.33.087.4

8622. A photoelectric setting device for a spectrum plate comparator. F. S. Tomkins and M. Fred. *J. Opt. Soc. Amer.*, **41,** 641–3 (*Sept.*, 1951).

A device for making comparator settings by photoelectric scanning of spectrum line images is described. The fiducial position is determined by matching mirror image oscilloscope traces of the line contour. This method combines the advantages of increased speed, precision, objectivity of setting, and decreased eye and nervous strain on the operator. The device is readily adaptable to comparators of the fixed microscope-moving plate type, and conversion from photoelectric to visual setting can be accomplished in a few minutes. A.

535.33

8623. The formation of molecular helium in a glow discharge. W. D. Parkinson. *J. Opt. Soc. Amer.*, **41,** 619–22 (*Sept.*, 1951).

The light from near the electrodes of an a.c. glow discharge in He is found to be particularly rich in the He_2 spectrum. This light occurs at an unusual phase of the voltage cycle. The process which forms excited molecules also gives rise to excited atoms. Furthermore the process is inhibited by the presence of an electric field. There are indications that the process is one of recombination between electrons and atomic positive ions. A.

535.338.4 : 539.13

8624. Predissociation and dissociation of the N molecule. A. E. Douglas and G. Herzberg. *Canad. J. Phys.*, **29,** 294–300 (*July*, 1951).

The predissociation in the upper state of the Lyman–Birge–Hopfield bands of nitrogen has been investigated under high resolution. A clear breaking off of the fine structure has been found above $v' = 6$, $J' = 13$ both in the P and the Q branches. The predissociation limit is at 78 843 ± 50 cm^{-1} which is smaller than the well-known dissociation limit 97 944 cm^{-1} by very nearly the excitation energy of the ^2D state of the N atom. This observation eliminates the intermediate value, 8·565 eV, for the dissociation energy of the N_2 molecule. A definite decision between the two remaining values, 9·75 and 7·373 eV, cannot yet be made. Acceptance of the former would involve the assumptions that the predissociation in the $a^1\Pi_g$ state is caused by the $^5\Sigma_g^+$ state resulting from normal atoms and that the $^5\Sigma_g^+$ state is not purely repulsive. The elimination of the value 8·565 eV for $D(N_2)$ removes the value 7·5$_0$ eV for D(CN) which has been fairly widely accepted.

535.338.4 : 539.12

8625. Spectrum and structure of the boron monosulphide (BS) molecule. P. B. Zeeman. *Canad. Phys.*, **29,** 336–56 (*July*, 1951).

Two band systems of the BS molecule, called the α and γ systems, have been excited in a discharge through B_2S_3 vapour in a quartz discharge tube. Vibrational and rotational analyses of these systems have been carried out, and it is shown that both systems have the same lower state ($^2\Sigma$); both the upper states are $^2\Pi$ states. The α system is analogous to the α system of BO, but the γ system has not been observed for BO. Tables giving the vibrational and rotational constants of the various states are given. A third system of strong bands in the blue-green region is observed simultaneously with the α and γ bands in the discharge. These bands have not yet been interpreted. By means of the observed isotopic bands it has been proved that BS is the emitter of the α and γ systems.

535.339.1

8626. Vacuum double monochromator for the ultra-violet. S. ROBIN and B. VODAR. Letter in *J. Phys. Radium*, **12**, 634–5 (*May*, 1951) *In French.*

[See S. Robin, Abstr. 6366 (1950)]. It is stated to consist of an Eagle mounting with an "Al on glass" N.P.L. ruled grating of 1 m radius and with 570 lines/mm. The dispersion is 18 Å/mm. Full details of the apparatus and pumping system are given in the S. Robin's *Diplôme d'Études supérieures*, 1949. A pressure of 10^{-6} mm Hg is obtained and a quartz H lamp is used as source. The results of two tests made with the instrument are briefly described.

S. WEINTROUB

535.34–15

8627. Contribution to the study of the intensity of rays and of absorption bands in the infra-red. J. VINCENT. Letter in *J. Phys. Radium*, **12**, 696–7 (*June*, 1951) *In French.*

Gives approximate ratio of intensities of harmonic bands of diatomic molecules with a Morse potential function and constant moving electric charge.

D. H. WHIFFEN

535.342

8628. Relation between the frequencies of isotopic molecules (sum rule). L. M. SVERDLOV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 6) 1115–19 (1951) *In Russian.*

The investigation of the isotopic effect in rotatory spectra is a great aid in the analysis of these spectra, as it facilitates their interpretation and yields additional equations for the determination of the constants of the potential energy. Relations between the frequencies of isotopic molecules are therefore of great practical interest. One of these was found by Teller and Redlich [*Z. Phys. Chem.*, **28**, 371 (1937)] and is known as product rule. The rule derived by the author is based on the simplifying assumptions that in a molecule of N atoms the fundamental oscillations of the nuclei are harmonic and that the kinetic and potential energy of the molecule may be represented as quadratic function of the generalized impulses and co-ordinates. The eigenfrequencies may then be found from the characteristic equation. A group of atoms in the molecule is then selected, divided into 2 sub-groups and the isotopic permutations carried through, first for the sub-groups and then for the whole group in the secular equation. Mathematically this amounts to interchanging the diagonal elements in the corresponding matrices. The sum rule is then obtained as result of a purely formal identity, i.e. that the sum of the diagonal elements of the secular equation must be equal to the sum of the roots of the secular equation (i.e. the sum of the squares of the frequencies). The method is then applied to acetylene, methane and ethylene as well as water, as numerical examples. For water the frequencies of H_2O, D_2O and two frequencies of HDO are known and agree remarkably well with the result obtained by the sum rule. B. F. KRAUS

535.342

8629. On the appearance of rotational and vibrational structure in gas and liquid spectra. G. KORTÜM. *Naturwissenschaften*, **38** (*No.* 12) 274–9 (1951) *In German.*

An interpretation is sought of apparent continua in regions where dissociation phenomena do not occur. Loss of fine structure is attributed to a shortening of the life-time of the combining energy states. Loss of rotational structure in gas spectra is due to Lorentz damping through impulses, loss of vibrational structure in gases and liquids to torsional vibrations of individual atomic groups. J. JACOBS

535.343

8630. On the theory of the continuous spectrum of methane and related molecules. M. A. KOVNER AND SH. E. TSIMRING. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 2) 235–7 (1951) *In Russian.*

The absence of vibrational structure in the absorption spectrum is not due to forbidden electron-vibration transitions. The spectrum coincides with a continuum as dissociation into radicals belonging to a different symmetry group must take place in tetrahedral molecules. J. JACOBS

535.343–15

8631. The infra-red spectrum and thermodynamic constants of nitrosyl chloride. A. G. PULFORD AND A. WALSH. *Trans Faraday Soc.*, **47**, 347–53 (*April*, 1951).

The i.r. absorption spectrum of nitrosyl chloride has been recorded over the range 2–25 μ. A vibrational assignment has been made which accounts satisfactorily for all the observed bands. The calculated thermodynamic data are in much better agreement with the thermal measurements than those calculated from a previous i.r. investigation, but the discrepancy between thermal and spectroscopic values is still greater than the experimental error. The band contours and calculated force constants are compatible with the structure deduced from electron diffraction measurements. A.

535.343–15

8632. Molar extinction coefficients of certain functional groupings with special reference to compounds containing carbonyl. L. H. CROSS AND A. C. ROLFE. *Trans Faraday Soc.*, **47**, 354–7 (*April*, 1951).

The amount of O as carbonyl in organic compounds may be estimated by an i.r. spectroscopic method. The method depends on observations that each class of carbonyl compounds possesses a characteristic frequency of absorption in the 6 μ region of the spectrum, and that the members of each class have very similar molar extinction coefficients when examined in fairly dilute solutions in non-associative solvents. Some figures are quoted for other functional groupings. A.

535.343–32 : 541.651

8633. The effect of substituents on the ultra-violet absorption spectrum of quindoline. E. GELLÉRT AND V. PETROW. *Experientia*, **7** (*No.* 7) 259–60 (1951).

A carboxyl at position 11 and an amino-group at 7 produce bathochromic shifts. The amino-group at 11 introduces a new maximum in the 300–350 mμ region. J. JACOBS

535.343.2

8634. Absorption spectra of chrome alum crystals. E. GOLLING. *Ann. Phys., Lpz.*, **91** (*No.* 2–4) 181–99 (1951) *In German.*

Absorption spectra of mixed crystals in which Al^{+++} or Fe^{+++} is substituted for Cr^{+++}, Se for S

and NH_4 for K, are measured at liquid air temperature. The energy-level diagram of $KCr(SeO_4)_2.12H_2O$ is almost completed. In the sulphates the principal line is surrounded by four sharp weak lines, which do not move when NH_4 is substituted for K, while the principal line moves; they belong to the transition to $^4F\Gamma_5$. No magnetic broadening is shown, as the effect is smaller than the temperature effect. Broadening and moving of lines is approximately linear for ternary mixed crystals. C. TURNER

535.343.2

8635. Oscillator strengths for the α- and β-bands in alkali halide crystals. D. L. DEXTER. *Phys. Rev.*, **83,** 1044–6 (*Sept.* 1, 1951).

The oscillator strengths for the α- and β-absorption bands are calculated for NaCl. These bands, investigated experimentally by Delbecq, Pringsheim and Yuster in Kl, lie on the long-wavelength tail of the first fundamental absorption band and are interpreted by use of a model according to which valence electrons of the adjacent halide ions are raised to bound states in the fields of negative ion vacancies (α-transitions) and *F*-centres (β-transitions). The oscillator strengths turn out to be only slowly varying with the assumed wave functions and are about 1·9 and 0·6 for the α- and β-bands, respectively. A.

535.343.2–15 : 541.65

8636. The infrared spectra of *N*-acetylglycine and diketopiperazine in polarized radiation at 25° and at − 185°C. R. NEWMAN AND R. M. BADGER. *J. Chem. Phys.*, **19,** 1147–53 (*Sept.*, 1951).

The absorption spectra of single crystals have been observed at room temperature, and at −185°C. In both cases cooling produces a pronounced narrowing of the broad bands due to the vibration of H atoms involved in strong H bonds. The two spectra furnish examples of NH absorption in the two extremes of weak and very strong H bonding. In diketopiperazine two possible interpretations of the doublet structure in the NH valence band are offered. A.

535.343.2–32

8637. The ultraviolet absorption spectra of glasses. K. OSADA. Note in *J. Phys. Soc. Japan*, **6,** 191–2 (*May–June*, 1951).

The ultra-violet absorption spectra of sodium glass, lead glass and brownish and greenish glasses and the reflectivity of sodium glass have been measured. W. R. ANGUS

535.343.31/.4 : 541.62

8638. Rotational isomerism in nitrous acid and alkyl nitrites. L. D'OR AND P. TARTE. Letter in *J. Chem. Phys.*, **19,** 1064–5 (*Aug.*, 1951).

The bands 1 650 and 600 cm^{-1} appear double and the temperature dependence of intensities support rotational isomerism. Intramolecular association yields 2 forms of HONO. J. JACOBS

535.343.31/.4 : 541.64

8639. Spectroscopic evidence of the dimerization of NO in the gaseous state. L. D'OR, A. DE LATTRE AND P. TARTE. Letter in *J. Chem. Phys.*, **19,** 1064 (*Aug.*, 1951).

With temperature rising from −180°C the continuous absorption is most intense near the boiling-point of NO and then regresses. Between 2 360 and 2 320 Å a weak system of 4 maxima is observed with an interval of 140 cm^{-1}, confirming the existence of N_2O_2. J. JACOBS

535.343.4–14 : 535.338.334

8640. Pressure broadening in the microwave spectrum of ammonia. C. A. POTTER, A. V. BUSHKOVITCH AND A. G. ROUSE. *Phys. Rev.*, **83,** 987–9 (*Sept.* 1, 1951).

Half-widths of five pressure-broadened lines of the NH_3 inversion spectrum have been measured as a function of total pressure. The perturbing gases were O_2, He and N_2O in various mix ratios. The results indicate a decrease in the collision diameters with increasing mix ratio of perturber to absorber. In the case of the nonpolar He and O_2 the observed variation of collision diameter with quantum numbers of the lines can be compared with the predictions of the theory of collision broadening developed by P. W. Anderson. The general trend of the variation agrees with the theory, but its observed magnitude is considerably greater than predicted. A.

535.343.4–14 : 539.133

8641. Microwave spectrum and dipole moment of methyl mercaptan. T. M. SHAW AND J. J. WINDLE. Letter in *J. Chem. Phys.*, **19,** 1063–4 (*Aug.*, 1951).

The most intense of 50 lines between 23 000 and 29 000 Mc/s is at 25 291 arising from a rotational transition of molecules in the ground state. The observed Stark behaviour makes this the $0_0 \rightarrow 1_-$ transition of $CH_3S^{32}H$ with a dipole moment along the least moment of inertia axis of 1·26 *D*. J. JACOBS

535.343.4–14 : 539.133

8642. Molecular constants of $Cs^{133}Cl^{35}$. R. G. LUCH AND J. W. TRISCHKA. Letter in *Phys. Rev.*, **83,** 851 (*Aug.* 15, 1951).

From the radiofrequency spectra of CsCl obtained by the electric resonance method of molecular beam spectroscopy, values of the permanent dipole moment, moment of inertia, rotational constant and internuclear distance for $Cs^{133}Cl^{35}$ are deduced. The quadrupole interaction of the two nuclei are believed to be of the same order, no resolution of the spectra into fine structure lines being possible. W. R. ANGUS

535.343.4–14 : 545.82 : 541.124

Microwave spectroscopic investigation of the kinetics of the heterogeneous ammonia-deuterium exchange. *See Abstr.* 9047

535.343.4–15

8643. Anomalous intensity distribution of rotation lines in fundamental vibration bands in triatomic molecules. H. H. NIELSEN. Letter in *Phys. Rev.*, **83,** 838 (*Aug.* 15, 1951).

A wave-mechanical explanation is proposed for the anomalous distribution, e.g. in the 3·8 μ-band in the H_2S spectrum. W. R. ANGUS

535.343.4–15

8644. The infrared spectrum of H_2S at 1·6 μ. R. MATHIS-NOËL. Letter in *J. Phys. Radium*, **12,** 764 (*July–Aug.–Sept.*, 1951) *In French.*

535.343.4–15 : 539.131

8645. The analysis of the infrared spectrum of chlorine monofluoride. A. H. NIELSEN AND E. A. JONES. *J. Chem. Phys.*, **19,** 1117–21 (*Sept.*, 1951).

The vibration-rotation fine-structure of the funda-

mental and first overtone of ClF has been resolved with grating spectrometers utilizing a 1 800 lines-per-inch and a 3 600 lines-per-inch grating. An analysis of the observed bands is given and the ω_e and $x_e\omega_e$ for $Cl^{35}F^{19}$ and $Cl^{37}F^{19}$ were found to be 786·34 cm^{-1}, 6·23 cm^{-1}, and 778·82 cm^{-1}, 6·11 cm^{-1}, respectively. A.

535.347–31

8646. Dichroism of stretched films. W. HANLE AND H. SCHERER. *Z. Naturforsch.*, **6a**, 437–40 (*Aug.*, 1951) *In German.*

The anisotropic light absorption of about 150 stretched coloured colloid films has been measured in the ultraviolet and the regions of dichroism are tabulated. By suitable choice of dye, dichroism can be obtained in any part of the spectrum. A.

535.371

8647. Phosphors for erythema lamps. I. I. KALINICHENKO, F. M. PEKERMAN AND A. K. TROFIMOV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 5) 887–8 (1951) *In Russian.*

Phosphors on a basis of phosphates of the earth-alkali metals of the 2nd group may yield specimens of very valuable practical characteristics, and radiations embracing a wide spectral range. Calcium phosphate activated by cerium radiates in a narrow u.v. spectrum (max. 365 mμ) and may be used for fluorescent lamps as exciter of fluorescent substances. Cadmium phosphate, on the other hand, radiates a wide spectrum (400–700 mμ) and is a good cathodoluminophor. Calcium phosphate activated by Tl represents a further extension of the spectral range towards the short-wave side of u.v. Best results yielded phosphates prepared by precipitation from ammonium phosphate and calcium chloride solution, thus approximately triple and double-substituted calcium phosphates. Such a mixture was the basis of phosphors of optimum luminescence characteristics when further mixed with $TlSO_4$ (Tl-conc. 5%) and kept at 900° for 17 hr. The spectrophotometrically obtained spectral curve has a maximum at 325 m and makes the phosphor particularly suitable for erythema lamps, as the curve of the antirhachitic activity of the u.v. radiation coincides in the range of 290–320 mμ with the curve of the erythema effect of the u.v. light. B. F. KRAUS

535.371

8648. Activator levels in the band model of sulphide phosphors. M. SCHÖN. *Z. Naturforsch.*, **6a**, 287–9 (*June*, 1951) *In German.*

It is shown that the activator impurity in the phosphor must give rise to three energy levels. The lowest is involved in optical transitions of electrons into the conduction band or from the valence (filled) band. The next level is involved in thermal interaction between the activator and the two above bands and the highest level is involved in optical transitions of electrons from the conduction band (emission process). The separation of these levels is of the order of 1/10 eV. G. F. J. GARLICK

535.371

8649. Properties of a $CaSO_4$: Mn phosphor under vacuum ultraviolet excitation. K. WATANABE. *Phys. Rev.*, **83**, 785–91 (*Aug.* 15, 1951).

The properties were investigated for use as a detector of extreme ultraviolet solar radiation in upper atmosphere research [see Abstr. 9209 (1951)]. The luminescence of particular interest was a long-period phosphorescence which is excited by wavelengths in the range 1 350 Å to gamma-rays. The energy stored in the phosphor after exposure to short u.v. was released by heating and measured by means of a photomultiplier. The stored energy was given by the integrated multiplier response and was independent of the form of the heating cycle. It was also nearly independent of the exposure temperature (−30 to +70°c) and humidity. There was a useful exposure range of 10^4 over which the stored energy was directly proportional to the exposure intensity and time; for higher exposures, saturation set in. The excitation spectrum of the stored energy was measured and the maximum quantum efficiency (5 to 10%) was found to lie at 1 030 Å. At room temperature, the long-period phosphorescence decay was of the hyperbolic type. Fluorescence in addition to phosphorescence was excited by wavelengths < 1 350 Å, and an additional excitation band of fluorescence only was found in the region 1 400–1 600 Å. The emission spectrum extended from 4 480 to 5 790 Å. A.

535.372 : 535.343.2

8650. Absorption and emission spectra of zinc oxide. K. V. SHALIMOVA. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 6) 1127–30 (1951) *In Russian.*

The luminescence of ZnO is known to be due to the presence of an excess of Zn atoms. Various excess percentages may be obtained by varying the thermal treatment after vacuum distillation of the pure Zn. Zn foils so obtained exhibit green, bluish-green, blue or orange-yellow luminescence. By indirect tests it was found that the green effect corresponds to small, the bluish-green effect to large Zn contents, and orange-yellow luminescence to a profuse Zn excess. It is also possible to obtain non-luminescent ZnO foils. The absorption and emission spectra were photographed at room temperature, higher temperature, and liquid air temperature. The spectra are given and discussed and a possible mechanism of the luminescence is outlined. B. F. KRAUS

535.375.5

8651. Depolarization of the lines in optical Raman spectra. P. P. SHORYGIN. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 469–72 (1951) *In Russian.*

The conception of the tensor additivity of the polarization characteristics of the chemical bonds of polyatomic molecules successfully used for determining the degree of depolarization of simple molecules must not be transferred to compounds with conjugate bonds. In Raman spectra of molecules with conjugate multiple bonds anomalies are observed, viz. reduction of the frequencies of the valency oscillations of the multiple bonds and increase of the line intensities which are due to the existence of a system of levels of electron excitation which differs from that of molecules without conjugate bonds. The measurements referred to the nitro-group of nitrobenzene and nitropropane and to the C=O band and band of the benzene ring of acetone toluene,

acetophenone, benzophenone, and, as an example of a molecule with a lengthened bond system, the aldehyde C_6H_5—CH=CH—HC=O. In the latter, the depolarization was reduced for the 1 600 band, and increased for the 1 000 band, and for the C=C and C=O bands, which thus all approached the level 0·5. The degree of depolarization of the more or less local oscillations of the carbonyl group depends on the geometrical configuration of the whole system. B. F. KRAUS

535.375.5

8652. Vibration spectrum of a single crystal of lithium sulphate monohydrate. C. VASSAS-DUBUISSON. *C.R. Acad. Sci., Paris*, **233**, 374–6 (*July* 30, 1951) *In French.*

535.375.54

8653. A note on Raman scattering in glasses. L. PROD'HOMME. *C.R. Acad. Sci., Paris*, **233**, 303–5 (*July* 23, 1951) *In French.*

The Raman spectrum of four types of crown and flint glass has been examined. In one case the work was done for both an annealed and a quenched specimen. The latter shows a band broadening characteristic of its more disordered structure.

R. O. DAVIES

535.376 : 537.311.33

8654. Injected light emission of silicon carbide crystals. K. LEHOVEC, C. A. ACCARDO AND E. JAMGOCHIAN. *Phys. Rev.*, **83**, 603–7 (*Aug.* 1, 1951).

Recombination of carriers injected through $p - n$ boundaries in SiC crystals may lead to light emission ("injected light emission"). This light emission was investigated as a function of temperature and of current through the crystal by use of a photomultiplier. The emission spectrum extends from 4 500 to 6 500 Å at room temperature and is found to be nearly independent of current from 0·1 to 50 mA. The light intensity increases approximately proportionally to current (efficiency about 10^{-6} quanta per electron at room temperature for a particular crystal). A.

535.379 : 541.126

8655. Chemiluminescence of the explosive decomposition of chlorine azide N_3Cl and nitrogen chloride NCl_3. Mechanisms of these reactions. G. PANNETIER. *C.R. Acad. Sci., Paris*, **233**, 168–70 (*July* 9, 1951) *In French.*

Gaseous N_3Cl and NCl_3 were exploded by means of an electric spark. The light emitted was analysed by a spectrograph aligned along the axis of the explosion tube. To obtain adequate density on the spectrographic plate, 10^3–10^4 exposures are necessary; to facilitate such multiple exposures automatic firing equipment repeating at the rate of one explosion per sec was used. For dry N_3Cl and NCl_3, the spectrum is a continuum extending well into the u.v., and having max. intensity at 5 000–5 500 Å. This suggests that in both cases the molecule disrupts into N and Cl, the continuum being emitted on recombination into N_2 and Cl_2. When H_2O is present, bands due to NH, OH and ClO appear. These may arise either from H_2O participating directly in the explosive decomposition of N_3Cl or NCl_3, or, more probably, from combination of the free radicals N and Cl with H_2O at a later stage in the reaction.

A. SCHOFIELD

535.39

8656. Reflection of light by multiple homogeneous thin and thick films. A. VAŠIČEK. *J. Phys. Radium*, **12**, 590–2 (*May*, 1951) *In French.*

A calculation is made for the reflection of light from glass coated with homogeneous multiple films. Different formulae are obtained according to whether one treats high on low index films or vice versa. The reflection formula is the same for both cases if one considers the reflection from glass coated with thick films (i.e. those thicker than the wavelength of the light used) and if one treats thick films as a limiting case of thin films. The result obtained for thick films is not dependent on whether the approach is made from the air side or the glass side. S. TOLANSKY

535.393

8657. Reflection and transmission of radiation by metal films and the influence of nonabsorbing backings. L. HARRIS, J. K. BEASLEY AND A. L. LOEB. *J. Opt. Soc. Amer.*, **41**, 604–14 (*Sept.*, 1951).

A set of equations is presented for the reflection and transmission of normally incident radiation by absorbing (metal) films on non-absorbing backings. Using these equations, the results of two different methods of calculation of the reflection and transmission coefficients of a thick non-absorbing plate are shown to be practically identical, both with and without an absorbing (metal) film on one surface of the plate. One of these methods involves the addition of intensities of the multiple reflections from the two surfaces of the plate. The other method is a rigorous calculation involving solution of the boundary condition equations (amplitude addition) for small areas followed by intensity averaging over the whole plate. In order to calculate optical constants of a metal film on a thick non-absorbing backing, the much simpler method of intensity addition of internal reflections in the backing may usually be applied. A.

535.41

8658. Interference of the two beams emerging from a Lummer–Gehrcke interferometer. E. CHARRON AND N. SÉGARD. *Rev. Opt.* (*Théor. Instrum.*) **30**, 261–94 (*June*, 1951) *In French.*

The two sets of coherent light beams which emerge from the upper and lower faces of a Lummer–Gehrcke interferometer in normal use can be made to interfere with one another. This leads to a new set of fringes which are described in detail and the theory discussed. Owing to the long path differences involved the fringes are only visible with monochromatic light. The fringe system is produced by an extended source. By interposition of a glass plate in one beam the paths can be brought to near equality to lead to the formation of white light fringes. A detailed numerical analysis is carried out for a particular plate with 18 emergent beams. S. TOLANSKY

535.41

8659. Some fringes seen in a Soleil compensator. J. E. H. BRAYBON AND H. C. JERRARD. *J. Sci. Instrum.*, **28**, 269–71 (*Sept.*, 1951).

Details are given of some fringe systems seen in

the continuous spectrum obtained when light, which has traversed a Soleil compensator mounted between a polarizer and analyser, is incident on a spectrometer. The fringes are caused by incorrect orientation with respect to one another of the optic axes of the plates: this is verified experimentally and explained theoretically. Fringes which occur when the field of view should be dark are due to reflection in the plates: they can be eliminated by filling the compensator with a suitable oil. The use of the fringes for adjustment of the plates of the Soleil compensator is mentioned. A.

535.417

8660. Transmission-like multiple beam reflection interferometry. C. F. BRUCE. *Aust. J. Sci. Res. A*, **4**, 117–30 (*June*, 1951).

The production of transmission-like multiple beam "Fizeau" fringes in reflection, which have high contrast and visibility, is described. These fringes arise, not essentially from the combination of particular reflectivities of the two plates of the interferometer system, but from the elimination of certain rays in the reflected system which differ in phase from other rays by π. The theory of their origin and the experimental conditions required for their production is given. Fringes of equal chromatic order with similar characteristics can also be produced. An application of these fringes to vibration measurement is described where they had important advantages over normal transmission and reflection fringes. A.

535.417

8661. An interferometer for the thickness measurement of thin transparent film. N. SIDJAK. *Canad. J. Techn.*, **29**, 362–70 (*July*, 1951).

For principle, see Abstr. 4505 (1949).

535.417 : 534.152

Measurement of the amplitude of vibration of piezoelectric crystals by an interference method. *See Abstr.* 8590

535.42

8662. Studies of transmission zone plates. O. E. MYERS, JR. *Amer. J. Phys.*, **19**, 359–65 (*Sept.*, 1951).

Methods of construction of transmission zone plates are considered. The use of the zone plate for focusing transmitted wavelengths ranging from the infrared to the very soft X-ray region is discussed. An investigation is made of the focal and chromatic properties of a zone plate to be used for visible and near ultraviolet light. Photographs of several lines of the Hg spectrum made by using a zone plate as the focusing "lens" are exhibited. The similiarity between the optical properties of a transmission zone plate and a converging lens are shown by both theoretical considerations and experiment. A.

535.435

8663. Theoretical study of light scattering by a fluid having one isotropic axis, application to nematic-type liquid crystals. P. CHATELAIN. *Acta Cryst.*, **4**, 453–7 (*Sept.*, 1951) *In French.*

A theoretical study is made of the scattering of light by a liquid composed of anisotropic particles which show fluctuations in orientation and are so distributed that the medium possesses a unique isotropic axis. Two cases are considered: (1) discrete anisotropic molecules; (2) large groups of parallel anisotropic molecules dispersed among isolated molecules. In the two cases the theory leads to depolarization factors greatly in excess of unity. Spherical groups, of radius $0{\cdot}1\ \mu$, containing 10^6 molecules of azoxyanisole arranged parallel and inclined at an angle $\theta < 36°$ to the isotropic axis and single molecules inclined at an angle $\theta > 36°$ are discussed in detail, and the results obtained agree in order of magnitude with experiment. It can, therefore, be concluded that in nematic liquid crystals diffusion is due to fluctuations in the orientation of the molecules round the isotropic axis and that the fluctuations in two molecules can be treated as independent only if their separation exceeds $0{\cdot}1\ \mu$. A.

535.551 : 541.65

8664. Double refraction of flow: numerical evaluation of extinction angle and birefringence as a function of velocity gradient. H. A. SCHERAGA, J. T. EDSALL AND J. O. GADD, JR. *J. Chem. Phys.*, **19**, 1101–8 (*Sept.*, 1951).

The method of double refraction of flow in systems containing large asymmetrical molecules gives experimental data which, when interpreted in light of the theory of Peterlin and Stuart, enable one to calculate molecular lengths; information about the polydispersity of the system and about the optical properties of the solute particles may also be obtained from such data. Heretofore, this theory had been developed so that the data could be interpreted only under the limiting condition of low velocity gradient where the degree of orientation of the solute particles is very small. With the aid of an automatic computer, the necessary equations have been solved to provide numerical values over a much wider range of velocity gradients, greatly increasing the usefulness of flow birefringence measurements for the study of macromolecular systems. A.

535.6.08 : 621.383 : 621.317.79

8665. Industrial tristimulus color matcher. G. P. BENTLEY. *Electronics*, **24**, 102–3 (*Aug.*, 1951).

An electronic colorimeter suitable for dark colours and with sensitivity greater than that of the eye is described. A reflectance standard and the unknown are located in the walls of an integrating sphere and their brightness is compared 30 times/sec, using a multiplier photocell as detector. A. H. W. BECK (R)

535.65 : 778.6

8666. Simplified index for colour of illuminants. F. F. CRANDELL, K. FREUND AND L. MOEN. *J. Soc. Mot. Pict. Televis. Engrs*, **56**, 386–97 (*April*, 1951).

The essential information regarding the colour characteristics of an illuminant used for colour photography can be expressed by means of two ratios, the blue-red and the green-red, and the authors describe a photoelectric instrument, analogous to a colour-temperature meter, by means of which these ratios can be readily determined. With this information, combined with analogous information regarding the colour sensitivity of the film used, it is a simple matter to determine whether correct colour balance will be obtained or whether correction filters are required and, if so, which of a certain range of filters should be used. J. W. T. WALSH

535.653.85

8667. A Munsell color book in textiles. H. R. DAVIDSON AND H. LUTTRINGHAUS. *J. Opt. Soc. Amer.*, **41**, 623–5 (*Sept.*, 1951).

535.818.2 : 771.351

8668. The natural vignetting of photographic objectives with given stop positions. W. UHL. *Optik*, **8**, 224–32 (*May*, 1951) *In German.*

The known (cosine)^4 law is established for the cases of a stop in front, behind and in the interior of a system respectively. It is shown that the Seidel distortion can be sufficient to more than compensate for the (cosine)^4 decrease in image illumination. See also Abstr. 6912–14 (1951). H. H. HOPKINS

535.823.51 : 778.31

8669. A combined mechanical stage and focusing control for photo-micrographic work. D. G. STEVENSON. *J. Sci. Instrum.*, **28**, 275 (*Sept.*, 1951).

A mechanical stage and focusing control designed for use on a medium power microscope used horizontally is described. The vertical and horizontal movements of the stage and the focus are controlled by the three-dimensional movement of a single knob. A.

535.824

8670. The rendering of amplitude, phase and polarization objects into a single, coloured image. H. WOLTER. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 57–64 (1951) *In German.*

Methods are described for combining phase contrast, bright field and polarizing microscopy to yield a coloured image in which changes of intensity, colour and saturation have significance. The application of phase contrast methods to schlieren photography in colour is also considered. A simple addition to a phase contrast microscope allows the rapid change from bright field to phase contrast microscopy. R. W. FISH

535.824 : 535.41

8671. Interference apparatus for the conversion of a microscope into an interference microscope. H. WOLTER. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 65–9 (1951) *In German.*

A simple attachment of high light grasp is described which renders visible phase objects. The interference is of low order so that white light or electronic flash may be used. Phase differences may be transformed into colour changes in the image. Polarizing objects can be used by introduction of a polarizer. The method is free from the false halo seen in normal phase contrast. R. W. FISH

535.827 : 539.27 : 576.3

8672. Optical methods in cytology. J. T. RANDALL. *Disc. Faraday Soc.*, *No.* 9, 353–60 (1950).

A review of recent applications of visual, u.v., i.r. and electron microscopy in cytology. 44 references. R. W. FISH

535.89 : 621.316.75

8673. A note on an automatic control for maintaining constant intensity of a light source. K. C. WIGHT. *J. Sci. Instrum.*, **28**, 276–7 (*Sept.*, 1951).

An electronic arrangement for automatically maintaining constant intensity of a light source using a tungsten filament lamp is described, in which normal electrical components are used. Curves show the stability over a period of some hours and the effect of mains voltage variation. The regulation of intensity for the latter, on a percentage basis, is about 150 to 1. A.

HEAT 536

536.2 : 536.58 : 621–526

8674. Influence of the transfer of heat on the stability of temperature controllers. P.-L. DUBOIS-VIOLETTE. *C.R. Acad. Sci., Paris*, **233**, 26–8 (*July* 2, 1951) *In French.*

The cylindrical propagation of heat is theoretically discussed using the Laplace transform in p. The transmission ratio $G(p)$ of the control servomechanism is shown to be of the form $1/f(p)$ where $f(p)$ is an integral function of p. The method of *C.R. Acad Sci., Paris*, **230**, 1380–3 (*April* 12, 1950) [Abstr. 2397 B (1950)] is then applicable, enabling the limits of stability to be calculated numerically. S. WEINTROUB

536.2 : 536.58 : 621–526

8675. Influence of the transfer of heat on the stability of temperature controllers. P.-L. DUBOIS-VIOLETTE. *C.R. Acad. Sci., Paris*, **233**, 232–4 (*July* 16, 1951) *In French.*

See previous abstract. The particular example of a crucible furnace, where the temperature is controlled through the supply of fuel to the heating flame, is theoretically treated. S. WEINTROUB

536.21.083

8676. Analysis of errors in measuring thermal conductivity of insulating materials. E. V. SOMERS AND J. A. CYPHERS. *Rev. Sci. Instrum.*, **22**, 583–6 (*Aug.*, 1951).

Thermal conductivity measurements made by the guarded-hot-plate method are subject to error from heat loss by convection at the exposed edges of the sample. Analytical solutions are found and plotted to show the maximum errors for square and round samples in apparatus of various dimensions. A.

536.212.2 : 536.48

8677. Thermal resistance of metal surfaces in contact at He temperatures. N. V. ZAVARITSKIĬ. *J. Tech. Phys., USSR*, **21**, 453–7 (*April*, 1951) *In Russian.*

The contact investigated was between two conical copper surfaces in a brass casing. The results were as follows: For small overtemperatures of the specimen above the surrounding He-chamber the heat exchange remains practically constant. The heat exchanged depends on the tight sealing of the mechanical contact between the two cones. At rising pressure p the specific heat exchange per cm^2 surface increases in direct proportion with p. At the instant of making and of breaking contact, the heat due to friction and to deformation is liberated. In the second case it depends on the speed of deformation, i.e. for steady separation it is 2×10^{-5} cal, at a sudden separation, 8×10^{-5} cal. Since the heat exchange through the contact depends linearly on the load, all the measure-

ments at variable loads may be referred to a constant load. The heat exchange decreases with the absolute temperature. At large temperature differences the exchange varies in the same sense as the differences.

B. F. KRAUS

536.212.2 : 536.48

8678. Heat conductivity of steels and a few other metals at low temperatures. J. DE NOBEL. *Physica*, **17**, 551–62 (*May*, 1951).

Heat conductivities of aluminium, iron, nickel, monel metal and of nickel-, manganese- and chromium steels have been investigated at the temperatures of liquid hydrogen and liquid air. The two methods employed to measure heat conductivities are described and results are given. A.

536.23 : 533.5 : 531.788.6

8679. On the conduction of heat in rarefied gases and its manometric application. I. H. VON UBISCH. *Appl. Sci. Res.*, **A2** (*No.* 5–6) 364–402 (1951).

Formulae for the conduction of heat in pure gases and in binary mixtures relevant to a tube with a thin, axial heated wire are developed. They cover the region of pressure between that for which the heat conduction is independent of pressure and that for which Knudsen's formula is valid. A theory for precision manometry is given and the manometric constants for twenty-five gases have been measured. A.

536.23 : 533.5 : 531.788.6

8680. On the conduction of heat in rarefied gases and its manometric application. II. H. VON UBISCH. *Appl. Sci. Res.*, **A2** (*No.* 5–6) 403–30 (1951).

The geometrical design of tubes for manometers, the design of circuits and the properties of direct-reading hot-wire manometers are investigated. Examples of improved manometers are given. Further possible improvements and leak-hunting are discussed. A.

536.242

8681. Heat transfer to a fluid flowing turbulently in a smooth pipe with walls at constant temperature. R. A. SEBAN AND T. T. SHIMAZAKI. *Trans Amer. Soc. Mech. Engrs*, **73**, 803–10 (*Aug.*, 1951).

The case of heat transfer to an incompressible fluid of constant properties flowing turbulently within a pipe having constant wall temperature has been investigated analytically. Heat-transfer coefficients have been evaluated and compared to the coefficients obtained by Martinelli for the same flow conditions in a pipe having a linear variation of wall temperature obtained from a constant heat-transfer rate along the pipe length. At low Prandtl numbers, such as obtained with molten metals, the ratio between the coefficients for these two cases may become as low as 0·73, with the coefficient for the constant-wall-temperature case being the smaller of the two. A simple equation of the Lyon type is indicated for the correlation of the present results. A.

536.243

8682. Heat transfer in laminary flow between parallel plates. J. A. PRINS, J. MULDER AND J. SCHENK. *Appl. Sci. Res.*, **A2** (*No.* 5–6) 431–8 (1951).

The heat transfer in a liquid when it passes in Poiseuille flow from a hot tube into a cold tube of the same diameter is known as Graetz' problem. The analogous problem with plane parallel plates substituted for the cylindrical tube wall is solved here by the introduction of a set of eigenfunctions y_n satisfying the Sturm–Liouville equation $y'' + E(1 - x^2)y = 0$. This solution is compared with the solution of Graetz' problem. A.

536.243 : 536.423.16

8683. On the theory of the heat and mass transfer from a sphere in a flowing medium at low values of Reynolds' number. R. KRONIG AND J. BRUIJSTEN. *Appl. Sci. Res.*, **A2** (*No.* 5–6) 439–46 (1951).

A perturbation method is developed for computing the heat transfer from a sphere at uniform constant temperature to a medium flowing past it as a function of the radius of the sphere, the velocity of flow and the thermal properties of the medium. The results are expressed by giving Nusselt's number as a power series of Péclet's number, the calculation being carried to the second approximation. The formula arrived at can easily be extended so as to apply to the evaporation of or the extraction from spherical droplets. The results are restricted to small values of Reynolds' number. A.

536.413

8684. Thermal expansion coefficients of α-monoclinic selenium. C. J. NEWTON AND M. Y. COLBY. Note in *Acta Cryst.*, **4**, 477 (*Sept.*, 1951).

536.413.3 : 541.57 : 548.0

8685. Thermal expansion of *p*-nitroaniline and *p*-dinitrobenzene. P. J. A. MCKEOWN, A. R. UBBELOHDE AND I. WOODWARD. *Acta Cryst.*, **4**, 391–5 (*Sept.*, 1951).

Measurements on the thermal expansion of single crystals of *p*-nitroaniline have been made over the range 90–293°K by X-ray methods. Mean values of the principal axes of the expansion ellipsoid are $\alpha_{11} = 150{\cdot}3 \times 10^{-6}$, $\alpha_{22} = 7{\cdot}5 \times 10^{-6}$, $\alpha_{33} = 24 \times 10^{-6}$. As the crystal is monoclinic α_{22} coincides with the *b* crystal axis; α_{11} makes an angle $\psi = 40°\ 2'$ with the *a* axis. The very large α_{11} expansion of the crystal coincides within 6° with the projection on the (010) plane of the short "polarization bonds" (2·66 Å) in *p*-nitroaniline. These bonds link the aromatic C atom *ortho* to the NH_2 group of one molecule and the O atom of an NO_2 group from an adjacent molecule. It is suggested that the marked anisotropic expansion of the crystal is due to anomalously large thermal expansion of the polarization bond, and that there is some tilting of the molecules in the crystal as the temperature changes, so as to maintain the polarization bond normal to the plane of the benzene rings. The very large thermal expansion must be due to a very unsymmetrical potential-energy curve, and the forces acting in the polarization bond cannot be wholly accounted for on the basis of normal intermolecular forces. Resonance effects between alternative bond structures may lead to an overlap of potential-energy curves and a consequent large anharmonicity of bond vibrations. A.

536.42

8686. On the transformation of long chain acid amides. T. SAKURAI. Note in *J. Phys. Soc. Japan*, **6**, 199–200 (*May–June*, 1951).

The transformations in solid phase of $C_{15}H_{31}CONH_2$

and $C_{17}H_{35}CONH_2$ are determined from measurements of specific heat and electric conductivity which, in the former case, increases after the transformation.
J. JACOBS

536.42

8687. Thermal transformation of anisotropic bodies. J. M. T. VIDAL. *C.R. Acad. Sci., Paris*, **233**, 24–6 (*July* 2, 1951) *In French.*

Mathematical. It is postulated that the thermal expansion of a body is equivalent to a continuous group of transformations of a domain in projective space, and it is shown that if a thermal symmetry analogous to the physical symmetry is admitted an affine projection for each crystal system can be predicted, e.g. a biaxial homography for the hexagonal system. S. WEINTROUB

536.42

8688. Thermal dilatation of bodies. J. M. T. VIDAL. *C.R. Acad. Sci., Paris*, **233**, 228–30 (*July* 16, 1951) *In French.*

Continuation of preceding Abstr. in which only the affine transformations between two distinct states of a body were considered. The action of heat is equivalent to a group of such transformations, viz. $\rho x_i' = \Sigma a_{ik} x_k$ ($i, k = 1, 2, \ldots 4$; $a_{ik} = \delta_i^4 a_{44}$) where the a_{ik} are real, continuous functions of the group generator, the "natural temperature" of the body. The additional postulate that the above group exists without the presence of a force, i.e. the heat is in the form of internal potential energy, is made. It is shown that the correspondence between points on the axes is a similitude, and this has been verified experimentally for quartz using a Chevenard dilatometer. The experimental results are briefly discussed.
S. WEINTROUB

536.421.1

8689. Thermal analysis of the system $PbBr_2$–PbO. L. M. KNOWLES. *J. Chem. Phys.*, **19**, 1128–30 (*Sept.*, 1951).

A thermal analysis of the system $PbBr_2$–PbO proved the existence of four compounds intermediate between $PbBr_2$ and PbO, namely $PbBr_2 \cdot PbO$, $PbBr_2 \cdot 2PbO$, $PbBr_2 \cdot 3PbO$ and $PbBr_2 \cdot 7PbO$. The compound $PbBr_2 \cdot PbO$ was unstable above 497°C, whereas the others were stable at their melting-points. Pure $PbBr_2 \cdot PbO \cdot H_2O$ (or Pb(OH)Br) was prepared and was found to decompose into $PbBr_2 \cdot PbO$ at temperatures above 150°C. This work offers an explanation for the discrepancies among data reported in the literature for the melting-point of $PbBr_2$. A.

536.423 : 542.48

Theory of distillation and other countercurrent processes. II. *See Abstr.* 9102

536.423.4

8690. Nucleation in very rapid vapor expansions. A. KANTROWITZ. *J. Chem. Phys.*, **19**, 1097–100 (*Sept.*, 1951).

In the Volmer theory, sub-critical droplets (embryos) with vapour pressure > their surroundings nevertheless grow statistically, because they exist in sufficiently greater numbers than neighbouring larger droplets. Thus the formation of nuclei against the thermodynamic barrier presupposes the presence of very large numbers of embryos of all sizes. An approximate lower bound for the time (nucleation time) required for the formation of this system of embryos can be calculated readily by (1) neglecting the thermodynamic barrier which impedes their formation; (2) assuming that when droplets contain a certain supercritical number, r, of molecules they grow very rapidly because their vapour pressure is considerably lower than their surroundings; (3) assuming that the formation of the embryo system begins when the vapour first becomes saturated. The equation for the rate of formation of embryos then reduces to the heat conduction equation yielding a simple solution. The lower bound sought is found to be inversely proportional to the fourth power of the degree of supercooling. Comparison with the experiments of Wegener and Smelt indicates that in some nozzle expansions the occurrence of nucleation is determined by this process. On this theory the thermal accommodation coefficient which determines the heat transfer and especially the accommodation coefficient for growth, which determines the probability of a molecule sticking to the surface, play a much more prominent role than they do in the Volmer steady-state theory. Comparison with experimental time lags for the condensation of H_2O in air at −30 to −60°C gives the order of magnitude of the accommodation coefficient for growth at 5×10^{-4}. A.

536.46

8691. An experimental study of the radiation of diffusion flames. F. GUYOMARD. *C.R. Acad. Sci., Paris*, **233**, 237–9 (*July* 16, 1951) *In French.*

The total radiation emitted by coal-gas flames was measured by means of a water-cooled pyrometer. The effect of the following factors was examined: (*a*) burner dia., (*b*) preheating the fuel, (*c*) preheating both fuel and air, (*d*) addition of C_6H_6. It was found that for both laminar and turbulent flames the total radiation is a linear function of the gas efflux: preheating the fuel alone causes no increase in radiation until the temp. exceeds 400–500°C, while preheating both fuel and air causes an initial decrease in radiation up to 400°C and then a gradual increase. The addition of 7–9% of C_6H_6 increases radiation by 150–250%. A. SCHOFIELD

536.461

8692. Effect of turbulence on flame propagation in gases. S. KUMAGAI AND I. KIMURA. Note in *J. Phys. Soc. Japan*, **6**, 197–9 (*May–June*, 1951).

The increase in rate of combustion of coal-gas air mixtures due to the increased turbulence produced by passage of the flame through a mesh or a perforated diaphragm is demonstrated by simultaneous schlieren photography and pressure recording. A. SCHOFIELD

536.461

8693. Deviation of the gases in a flame. Radius of curvature of the blue cone at its apex. P. RENOUARD. *C.R. Acad. Sci., Paris*, **233**, 235–7 (*July* 16, 1951) *In French.*

Theoretical. The gas velocity parallel to the flame front being assumed const. and the normal component $\propto$ gas density the path followed by an element of gas

initially at temp. T_0 and moving at velocity V_0 along the axis of the flame-cone can be calculated if the density variation is known. The pressure is assumed const., so that density variation $\propto$ temp. variation; the temp. T at distance x ahead of the reaction zone is given by $T = T_0 + (\tau - T_0)e^{x/b}$, where τ is the ignition temp., $b = \lambda/V\rho_0 C$, λ = thermal conductivity, ρ_0 = initial density, V = velocity, and C = specific ht, of the unburnt gas. In this way it is found that each streamline suffers a displacement $b \tan \alpha \log \tau/T_0$ along the flame front, where α is the semi-angle of the conical flame. Using this relation, and assuming that the gas velocity is const. over the whole of the spherical cap, the radius of curvature is estimated by equating mass flow through the spherical tip with that in the corresponding section of the undeviated stream. A. SCHOFIELD

536.48

8694. On the explosion of air-rectifying apparatus. III. Y. NOMURA AND E. KANDA. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 471–6 (*June*, 1950).

For Pt II, see Abstr. 5361 (1951). Having shown that a possible hazard in air-liquefaction consists in an explosive reaction between C_2H_4 and O_3, the mechanism of initiation of this reaction was studied in detail. It was found that at pressures of a few mm Hg a rapid reaction occurred without observable delay between room temp. and −150°C. The reaction occurred more readily when the products of a previous explosion were left condensed on the walls of the reaction vessel. The condensed product was shown not to be ethylene ozonide. It is suggested that the reaction is initiated by a primary surface chain caused by collision of C_2H_4 and O_3 molecules at the wall, the primary carrier being O_2 or O. This primary chain induces a gaseous phase explosion. A. SCHOFIELD

536.48 : 532.511

8695. On two formulations of hydrodynamics, and the problem of liquid helium II. I. PRIGOGINE AND P. MAZUR. *Physica*, **17**, 661–79 (*July*, 1951) *In French.*

The hydrodynamics of a fluid consisting of several components can be formulated in two different ways by applying the methods of the thermodynamics of irreversible processes. The first formulation is obtained if Gibbs' fundamental formula for the entropy per unit of mass of the system is assumed to be still valid when applied to the movement of the centre of gravity of the system; statistically this corresponds to an approximate equilibrium velocity distribution function around the mean mass velocity, that is, to a normal transfer of impulse between the various components. This first formulation contains the classical Stokes–Navier equation for the hydrodynamics of a fluid. A second formulation is obtained if we assume the transfer of impulse between the various components to be a small perturbation or even negligible. This corresponds statistically to approximate equilibrium velocity distribution function around the macroscopical velocity of each component or "fluid." Assuming therefore Gibbs' formula for the entropy s_a per unit of mass of each fluid to be still valid when applied to the macroscopical movement of each fluid, a new set of hydrothermodynamical relations can be derived. When specializing these equations to the two-fluid model of liquid He II, Gorter's equations of motion for the normal and the superfluid are obtained. A.

536.48 : 532.511

8696. On the hydrodynamics of liquid mixtures of He^3 and He^4. P. MAZUR AND I. PRIGOGINE. *Physica*, **17**, 680–93 (*July*, 1951) *In French.*

The hydrothermodynamic treatment of several-fluid systems, based on the assumption of an inhibition of the transfer of impulse, is extended to the case where each fluid consists of more than one component. The theory shows that equations of motion can be set up for every fluid, whereas equations of diffusion describe the relative movements of the components belonging to one fluid around the centre of gravity of that fluid. The results can be applied to liquid mixtures of He^3 and He^4, assuming these mixtures to consist of a normal fluid containing He^3 and the normal fraction of He^4, and a superfluid of He^4 only. A quantitative discussion is given of several effects arising in this system. A.

536.48 : 532.511

8697. On the thermodynamic equation of motion of the two fluid model of helium II. T. USUI. *Physica*, **17**, 694–702 (*July*, 1951).

See Abstr. 7954 (1950). The general thermodynamics of irreversible processes in liquid He II is treated formally on the basis of two-fluid model. The thermodynamic equations of motion thus obtained on the assumption of thermostatical local equilibrium are found to agree with those of Gorter in their essential character. The validity of H. London's equation stipulates that the expression for entropy per unit mass, s, should be a product of the concentration of normal component, ξ, and a function of p and T, but this latter function is approximately independent of T. The velocities of wave propagation are obtained as $(\partial p/\partial_s)_s$ and $\xi(1-\xi)\ (\partial_s/\partial\xi)_p\ (\partial T/\partial\xi)_p$, respectively. These results are independent of the validity of H. London's equation. The corresponding attenuation coefficients are given formally. A.

536.48 : 536.423.15

8698. The vapour pressure of liquid helium at the lambda-point. E. LONG AND L. MEYER. Letter in *Phys. Rev.*, **83**, 860 (*Aug.* 15, 1951).

A redetermination of this quantity by the same method as that used by Schmidt and Keesom. $p_\lambda = 38{\cdot}10 \pm 0{\cdot}02$ mm Hg. R. B. DINGLE

536.48 : 536.51

8699. The temperature scale of the Ohio State University Cryogenic Laboratory. T. RUBIN, H. L. JOHNSTON AND H. ALTMAN. *J. Amer. Chem. Soc.*, **73**, 3401–4 (*July*, 1951).

A constant-volume helium thermometer has been designed and developed as the primary temperature standard, for the temperature range 13 to 300°K. A series of calibration runs showed that the final temperature scale is accurate, in terms of the thermodynamic scale, to within 0·01° below 30°K, to within

0·02° up to 150°K, and to within 0·025° up to 300°K. This thermometer is used to calibrate, simultaneously, two copper-constantan thermocouples and a strain-free platinum-rhodium resistance thermometer, which serve as direct standards to calibrate instruments in use in the laboratory. A.

536.483 : 533.6.011

8700. Modified Hilsch apparatus for producing hot and cold air streams. J. BERTIN. Letter in *J. Sci. Instrum.*, **28**, 251 (*Aug.*, 1951).

See Abstr. 5785 (1950).

536.531

8701. Measurement of high temperatures in gas streams. G. DÄTWYLER. *C.R. Acad. Sci., Paris*, **233**, 131–3 (*July* 9, 1951) *In French.*

The hot wire anemometer, with compensation for thermal lag is considered to be the best method. The technique is briefly outlined. E. H. DOCK

536.58

8702. Metal cryostat for the study of solid deposits obtained by freezing with a jet of gas. J. ROMAND AND B. VODAR. Letter in *J. Phys. Radium*, **12**, 631–2 (*May*, 1951) *In French.*

A brief description, with diagram, of the construction is given. The arrangement is particularly suitable for optical measurements. The deposits are *in vacuo* and temperatures down to 14°K can, in principle, be reached. A photograph of the u.v. absorption spectrum of solid benzene obtained using the cryostat is shown. [See also J. Mayence and B. Vodar. Abstr. 4031 (1950)]. S. WEINTROUB

536.62

8703. An isothermal calorimeter for measuring low rates of heat evolution over long periods. A. THOMAS. *Trans Faraday Soc.*, **47**, 569–73 (*June*, 1951).

A calorimeter of novel design, capable of measuring the evolution of heat at 80°C at the rate of 1 cal/hr continuously over long periods (100 hr or more), has been developed during the study of heats of atmospheric oxidation of solid materials. The design, development and use of the calorimeter are described in detail. A.

536.631

8704. External frequencies and specific heat of calcite. L. GIULOTTO AND A. LOINGER. *Nuovo Cim.*, **8**, 475–86 (*July*, 1951) *In Italian.*

Calculations of the 10 external optical frequencies of the unit cell of calcite lattice are reported. Assuming for the potential energy relative to elastic deformations an expression justified by reasons of symmetry, the external frequencies depend on 5 constants. By the assumption as data of 4 frequencies and of the intensity ratio of the 2 external Raman lines, the remaining frequencies are calculated. In this way it is possible to determine the specific heat of calcite as a function of temperature; the agreement with experimental data is satisfactory. A.

536.631

8705. On the specific heat of vanadium sesquioxide between 70 and 300°C. J. JAFFRAY AND R. LYAND. *C.R. Acad. Sci., Paris*, **233**, 133–5 (*July* 9, 1951) *In French.*

C_p for vanadium sesquioxide has been measured between 70 and 300°C. Anomalies have been found at 110–112°C and 258–260°C; the lower of these probably coincides with the transformation to constant paramagnetism and the other is undoubtedly associated with the dilatation anomaly observed by Foëx. F. E. HOARE

THERMODYNAMICS 536.7/.8

536.7

8706. Technical thermodynamics. A. PISCHINGER. *Vienna, Springer-Verlag* (1951) 251 *pp. In German.*

A textbook for advanced students covering the basic principles of thermodynamics such as the gas laws, entropy, specific heat, etc., and then dealing with the combustion of gases and the effects of dissociation on combustion. Details are given of the flow of gases through channels and nozzles, the behaviour of compressors, the characteristics of internal combustion engines, turbines, refrigerators and steam engines. The book concludes with many useful tables. A. C. WHIFFIN

536.7 : 533.21

Thermodynamical properties of argon. *See Abstr.* 8574

536.71

8707. On the equation of state of alkali metals. P. GOMBÁS. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 70–6 (1951) *In German.*

A previous calculation [Abstr. 1918 (1946)] depending on a Thomas–Fermi description of the metal ions is shown to lead to the relation $x_0 p = 3/2(1 - q^{\frac{1}{3}}/q^2)$ [x_0 = compressibility at 0° K; p pressure; $q = V/V_0$ where V = volume]. This is shown to be in close agreement with experimental data for Na, K, Rb and Cs. J. R. MADDOX

536.71

8708. On the impossibility of comparing the helium λ point to a triple point. J. P.-E. DUCLAUX. *C.R. Acad. Sci., Paris*, **232**, 2409–11 (*June* 25, 1951) *In French.*

Formulae supposedly valid for all fluids are employed to calculate the triple point constants for liquid He I. This leads to temperature and pressure values where it is known no triple point exists. F. E. HOARE

536.71 : 536.44

8709. Polyatomic molecules and the law of corresponding states. N. TRAPPENIERS. *Physica*, **17**, 501–10 (*May*, 1951).

The classical law of corresponding states does not apply to the curves of fusion and transition of polyatomic molecules. It is shown that for certain molecules of simple structure, a more exact expression of the law of corresponding states can be obtained (*a*) by introducing a reduced geometrical parameter, (*b*) by writing the intermolecular potential in the form $\sum_{i>j} \sum_{k,l}^{n} \phi_0 f(r_{ik,jl}/r_0)$, where $f(r_{ik,jl}/r_0)$ represents the potential energy of a pair of atoms k, l belonging to two different molecules i and j. The new expression of the principle of correspondence is applied to the diagrams of state of CCl_4 and CBr_4, whose molecules

satisfy the required conditions. Good agreement is obtained for the correspondence of the points of fusion and transformation, as well as for the curves of polymorphic transition at high pressure. A.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

ELECTROSTATICS . DIELECTRICS 537.2

537.212 : 621.3.011.4 : 621.3.013

8710. The two-dimensional field problem of two conducting planes. I. E. R. BERGER. *Öst. Ingen.-Arch.*, **5** (*No.* 2) 174–82 (1951) *In German.*

The field between two symmetrically placed plates with opposite charges is evaluated by conform representation and the capacitance of the arrangement is determined. Formulae are provided for the calculation of the unknown constants and a numerical example is given. A.

537.226.2

8711. Domain structure and dielectric response of barium titanate single crystals. B. MATTHIAS AND A. VON HIPPEL. **Domain structures and phase transitions in barium titanate.** P. W. FORSBERGH, JR. **Electric and optical behaviour of $BaTiO_3$ single-domain crystals.** W. J. MERZ. *Overseas Res. Rep.* 227/51 [*Dep. Sci. Industr. Res. Lond.*]; *Off. Tech. Serv. Wash., PB* 110302, 110310, 110311.

The first report (23 pp., Feb., 1948) gives the results of experiments in which single crystals of $BaTiO_3$ have been grown and investigated by means of the polarization microscope, X-ray diffraction and their dielectric and piezoelectric response. It was found possible to see the domains in the ferro-electric state and to change their number, size and orientation. Wall displacements and the alignment of such domains have been observed in both polarized and unpolarized light, and the influence of temperature and electric fields on the domain structure and orientation of the polar axis have been investigated. In addition to the Curie point near 120°C, there exist two polymorphic transitions near 5°C and − 70°C. A tentative explanation for the development of the ferro-electric state is given which brings the new ferro-electric group of the titanates into close relation with those of the tartrates and phosphates.

The second (62 pp., May, 1949) describes a study of the arrangements of domains that arise in single crystals of $BaTiO_3$ in the ferro-electric tetragonal phase. The domains are the result of tetragonal (101) twinning, and appear by the formation of wedge-shaped laminar domains between two converging (101) twin planes. A preliminary investigation of the phase transitions near 5° and − 70°C was made. It was concluded that the crystal is orthorhombic C.m.m. between 5° and − 70°C and trigonal R3m below − 70°C, with the lattice stretched along the polar axis. The twinning is identified in terms of these lattices. It is maintained that the transitions near 5° and − 70°C can only be of the first order, in contrast with the λ-transition at 120°C. A qualitative thermodynamic correlation of its properties has been made. Due to the piezoelectric interaction, the free energy can be visualized in the ferro-electric states in terms of a simultaneous polarization and lattice deformation.

The third (18 pp., June, 1949) reports the measurement, as a function of temperature, of the dielectric constants, the spontaneous polarization and the optical properties of $BaTiO_3$ single-domain crystals. It is shown that the deformation of the crystal in the tetragonal state is proportional to the square of the spontaneous polarization, in analogy to the behaviour of the other ferro-electrics, and that the temperature dependence of the birefringence is proportional to the square of the spontaneous polarization. The change of the polarization at the two lower transition points is consistent with the assumption that the Ti ions in the oxygen octahedra are displaced from the (001) to the (011) and later to the (111) direction. A.

537.226.2

8712. The static dielectric constant of dipolar solids. J. H. SIMPSON. *Brit. Elect. Res. Ass. Ref. L/T215*, 7 *pp.* (1951). For abstr. see Abstr. 7834 (1951).

537.226.2

8713. The dielectric properties of various solid crystalline proteins, amino acids and peptides. S. T. BAYLEY. *Trans Faraday Soc.*, **47**, 509–17 (*May*, 1951).

The dielectric properties of the proteins insulin, chymotrypsinogen, salmine sulphate and bovine serum albumin, the peptides glycylglycine and diglycylglycine, and the amino acids glycine and glutamic acid, in the solid crystalline state have been studied, in most cases over both the frequency range 300 to 4×10^9 c/sec and the temperature range − 100 to 0°C. The presence of adsorbed water was found to cause increases in both dielectric constant and power factor towards low (audio) frequencies, the effect being attributed chiefly to inhomogeneities and ionic conduction in the materials. Dispersions have been found at centimetre wavelengths for the substances examined. Measurements on the proteins *in vacuo* indicate that relaxation of polar groups occurs at audio frequencies, being rather more marked in chymotrypsinogen and insulin; an explanation of this difference in terms of the amino acid compositions is not entirely satisfactory. A.

537.226.2

8714. The dielectric properties of adsorbed water layers on inorganic crystals. S. T. BAYLEY. *Trans Faraday Soc.*, **47**, 518–22 (*May*, 1951).

Small amounts of adsorbed water have been found to cause peaks at about − 30°C in the variation with temperature of the dielectric constant and power factor of a number of inorganic crystals. A note is added on the dielectric changes accompanying the λ-point transition of $(NH_4)_2SO_4$. A.

537.226.2

8715. On the ferroelectric behaviour of sodium vanadate. S. SAWADA AND S. NOMURA. Note in *J. Phys. Soc. Japan*, **6**, 192–3 (*May–June*, 1951).

Sodium vanadate shows the characteristic domain

pattern and hysteresis effects of a ferro-electric material, although the permittivity is small and there is only a slight peak at the Curie point. E. RUSHTON

537.226.2

8716. Dielectric properties of lead zirconate. G. SHIRANE, E. SAWAGUCHI AND Y. TAKAGI. Note in *J. Phys. Soc. Japan*, **6**, 208–9 (*May–June*, 1951).

Pure lead zirconate has not the properties of a ferro-electric material, there being no evidence of spontaneous polarization below the Curie point.

E. RUSHTON

537.226.2

8717. The dielectric constants of gases in the microwave region. A. GOZZINI. *Nuovo Cim.*, **8**, 361–8 (*June*, 1951) *In Italian.*

A new method is described, utilizing spurious reflections in mismatched waveguides. Results are given for H_2, air and CO_2. A.

537.226.2

8718. The dielectric dispersion of dioxan-water mixtures. J. B. HASTED, G. H. HAGGIS AND P. HUTTON. *Trans Faraday Soc.*, **47**, 577–80 (*June*, 1951).

Measurements have been made of the dielectric constants and losses of dioxan-water mixtures, up to 45% dioxan, at 9·22 and 1·26 cm wavelength. The single relaxation time τ of water is raised from $0{\cdot}83$ to $1{\cdot}43 \times 10^{-11}$ sec when 45% dioxan is added, whilst the static dielectric constant falls linearly, giving a molar decrement of $-7{\cdot}7$ in agreement with previous workers. Dependence of τ on temperature gives an energy of activation of relaxation $\Delta H^{\neq}$, 20% lower than that of pure water. A.

537.226.2

8719. The dielectric behaviour of water in water–dioxan mixtures. H. F. COOK. *Trans Faraday Soc.*, **47**, 751–5 (*July*, 1951).

An investigation at microwave frequencies of the dielectric properties of water–dioxan mixtures has been carried out. The experimentally derived static dielectric constants of mixtures are analysed in terms of Kirkwood's theory for liquid dielectrics. The relaxation time of water in water–dioxan mixtures has been found to be greater than the value in pure water. The ratio is approximately 2 at the highest concentrations investigated. A.

537.226.2 : 538.221 : 621.3.011.5 : 621.318.2

8720. On the dielectric and magnetic properties of several ferrites at high frequencies. II. F. WAGENKNECHT. *Frequenz*, **5**, 186–90 (*July*, 1951) *In German.*

For Pt I, see Abstr. 7839 (1951). The variation with frequency of permittivity and loss-factor for a wide range of ferrites is shown by several graphs over the range 172–10 000 Mc/s. The influence of structure on these and optical properties is discussed in minute detail and a tabular analysis presented. A bibliography of 71 references is included. S. C. DUNN (R)

537.226.2 : 539.501 : 541.182

8721. Dielectrics and rheology of dispersed magnetized particles. A. VOET AND L. R. SURIANI, *J. Coll. Sci.*, **6**, 155–61 (*April*, 1951).

A dispersion of iron globules in a non-aqueous vehicle showed only little particle agglomeration. When placed in a magnetic field, however, the particles showed strong agglomerating tendencies, leading to the formation of linear particle chains. These chains are orientated in a magnetic field, but show a random orientation in the absence of a magnetic field. Dielectric characteristics gave a more accurate picture of the inner structure of the dispersion than did rheological data, since the shear necessarily applied in the latter case destroys the particle agglomeration. A.

537.226.2 : 541.57

8722. The dielectric properties of symmetrical long-chain secondary alcohols in the solid state. R. J. MEAKINS AND R. A. SACK. *Aust. J. Sci. Res. A*, **4**, 213–28 (*June*, 1951).

Symmetrical long-chain secondary alcohols in the solid state show very high dielectric loss at audio and radio frequencies. This can be explained by the presence of chains of OH groups linked by H bonding and capable of reversing their direction. Further evidence of H bonding is provided by a study of the melting points of the secondary alcohols and related compounds. The amount of dielectric loss depends markedly on the manner of formation of the solid, being smallest for samples formed by recrystallization from solvents at low temperatures and largest for specimens obtained by slow cooling from the melt. The alcohols of molecular chain-lengths of 13, 15, 17 and 19 C atoms show a considerable decrease of absorption on storing at room temperature. For alcohols of between 23 and 43 C atoms the loss is rather smaller with a peak at higher frequencies, but remains more constant in time. These results are interpreted in terms of competing influences of van der Waals forces and H bonds during crystal formation; the former, which lead to a structure unsuitable for the formation of H-bond chains, are predominant at low temperatures, but become more rapidly neutralized by thermal motion, especially for the shorter molecules. The high-temperature modification of the lower homologues is unstable at room temperature, and a molecular diffusion process causes the bond chains to break. Dilute systems of secondary alcohols with hydrocarbons or paraffin wax of similar molecular chain-length show very small dielectric loss, suggesting a solid solution in which bond chains cannot be formed; if the paraffin molecules are appreciably longer, the absorption is large and decreases on storing, presumably owing to the presence of a pure alcohol phase. A.

537.226.2

8723. On the dielectric loss in polydisperse polar polymers. S. OKA AND O. NAKADA. Note in *J. Phys. Soc. Japan*, **6**, 195–7 (*May–June*, 1951).

By choice of a rather general distribution function Φ the dependence of dielectric loss on Φ is investigated.

J. JACOBS

537.226.3

8724. The noise of decaying electrets. S. KOJIMA AND K. KATO. Note in *J. Phys. Soc. Japan*, **6**, 207 (*May–June*, 1951).

Barkhausen noise is observed during the decay of homocharge, but not during the decay of heterocharge. See also Abstr. 6191 (1949). J. H. MASON

537.228.1

8725. An interpretation of the piezoelectric loss due to the rotation of dipoles. N. Saitô. Note in *J. Phys. Soc. Japan*, **6**, 201–2 (*May–June*, 1951).

The random forces of Brownian motion affect the energy dissipation. J. JACOBS

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.31

8726. Temperature variation of the electrical properties of thin films containing gaps. J.-P. Borel. *C.R. Acad. Sci., Paris*, **233**, 296–7 (*July* 23, 1951) *In French.*

Measurements of resistance R of Ag films between 4 and 12 μ thick and deposited on amorphous quartz are described. Films less than 10 μ thick do not obey Ohm's law. For a given constant applied voltage R increases irreversibly with temperature to a limiting value. For films 11 to 12 μ thick there are reversible changes and a minimum R is observed.

C. A. HOGARTH

537.311.31 : 536.48

8727. The electrical resistance of silver-manganese alloys at low temperatures. I. The resistance from 273°K to 1°K. A. N. Gerritsen and J. O. Linde. *Physica*, **17**, 573–83 (*June*, 1951).

The electrical resistances of wires of Ag–Mn alloys, with concentrations of Mn up to about 20 atomic %, have been determined at low temperatures. Investigations show that at temperatures in the range 0° to 20°K anomalies occur in the resistance-temperature relation. For the most dilute alloys, the resistance-temperature curves show a first minimum and then a maximum when decreasing the temperature. As a possible explanation the authors suggest that the energy of the unfilled *d*-level of the Mn atom may be a few cm^{-1} above the Fermi level of the *s*-electrons in the metal. See Abstr. 8744 (1951). A.

537.311.32

8728. Electric conduction in ionic crystals. I. C. Okazaki and T. Suita. Note in *J. Phys. Soc. Japan*, **6**, 200–1 (*May–June*, 1951).

Measurements of the conductivity σ of single crystals of KCl with small traces of $SrCl_2$, using a d.c. field of 1 000 volt/cm and a galvanometer for the measurement of current, always give a value of 0·81 eV for the activation energy above 200°C, in agreement with Lehfeld's results. Discontinuities in the $\log \sigma$ *v.* $1/T$ curves below 200°C are considered to be due to space charge effects probably near the junctions with the electrodes. C. A. HOGARTH

537.311.33

8729. Theory of the issue of electrons from a metal in an electric field. A. E. Glauberman and I. I. Talyanskiĭ. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 4) 661–4 (1951) *In Russian.*

The contact of a metal with a crystalline semiconductor or dielectric is considered on a simplified model (neglecting the distortion of the energy spectrum near the surface) and the electron current passing from the metal into the conductivity zone of the crystal is calculated by means of the tunnel effect. Electrons whose kinetic energy > the limiting Fermi energy in the metal are regarded as "thermal" metal electrons. The resulting triple integral comprises the coefficient of transparency for electrons of the energy W_x, considering the presence of a periodic potential field in the metal and in the crystalline semiconductor. Such a coefficient was calculated by Zener for electron transition from one zone to another inside the semiconductor [*Proc. Roy. Soc. A*, **145**, 523 (1934)]. The author shows how to carry through the integration with Zener's function substituted and considering the temperature for the Fermi distribution of the electrons in the metal (in addition to the dependence of the current on field strength). The temperature-dependence component of the current is essential for the total current, as a tabulation of the results for different field strengths shows. The second section of the paper gives the results of the method applied to the issue of electrons into vacuum. B. F. KRAUS

537.311.33

8730. On the question of the resistive layer in copper-oxide rectifiers. I. Experiments on bulk specimens with barrier-free contacts. F. Rose. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 97–123 (1951) *In German.*

Impedance measurements up to 100 kc/s were carried out and new observations concerning the conducting layer on the copper side of Cu_2O rectifiers were made. The presence of conducting layers in the interior of the Cu_2O and at the counter-electrode could be established. Measurements on bulk specimens between 195° and 303°K were also carried out. The results yield information concerning the effect of the surface layer at the Ag contact, the conductivity of Cu_2O measured without barrier effects, and the activation energy for the production of defects. A modification of Lehovec's method for the evaluation of impedance and conductivity of barrier-layers is described. C. A. HOGARTH

537.311.33

8731. On the question of the resistive layer in copper-oxide rectifiers. II. Experiments on rectifier discs. F. Rose. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 124–40 (1951) *In German.*

Measurements of impedance up to 100 kc/s of Cu_2O disks were made from 195° to 303°K. Various materials were used for the rectifiers formed at different rates of cooling. The results are analysed by Lehovec's method. C. A. HOGARTH

537.311.33

8732. On the theory of semiconductors with mixed conductivity. A. I. Gubanov. *J. Exp. Theor. Phys., USSR*, **21**, 79–87 (*Jan.*, 1951) *In Russian.*

In elucidating semiconductor phenomena such as rectification, contact resistance, etc., the general equations of motion of current carriers are developed, taking into account: (*a*) simultaneous activity of both electrons and electron-holes; (*b*) the volume charge and the distortion zone produced by it, which plays an essential part in contact phenomena; (*c*) the

dependence of the time of life of holes and electrons on the concentration of free and fixed ions, with the variation of this concentration from point to point of the semiconductor. Also, instead of the equation of chemical equilibrium of electrons at the various energy levels employed in previous work, the chemical kinetic equations of transition of electrons from one level to another is used. Approximate methods of solution of the equations in boundary conditions corresponding to the electric field, diffusion, recombination and capture by ions are indicated.

F. QUELON

537.311.33

8733. On the conductivity of thin carbon films. A. BLANC-LAPIERRE, M. PERROT AND N. NIFONTOFF. *C.R. Acad. Sci., Paris*, **233**, 141–3 (*July* 9, 1951) *In French.*

Measurements of resistance of thin films of pure carbon deposited on glass and kept in a desiccator are described. Films up to 0·5 MΩ initial resistance and applied voltages of from 0·1 to 40 volts were employed. Reversible and irreversible effects are observed, depending on the heating effects and associated voltage changes due to the passage of the current and to the duration for which it is applied.

C. A. HOGARTH

537.311.33

8734. The effect of fluctuations in thin carbon films. A. BLANC-LAPIERRE, M. PERROT AND N. NIFONTOFF. *C.R. Acad. Sci., Paris*, **233**, 241–3 (*July* 16, 1951) *In French.*

See also preceding Abstr. Experimental results concerning voltage fluctuations in thin carbon films for applied d.c. voltages are described, together with comparative results for carbon resistors.

C. A. HOGARTH

537.311.33

8735. Volume rectification in zincite. S. R. KHASTGIR, S. K. R. TOLPADI AND S. C. MITRA. Letter in *Nature, Lond.*, **168**, 162–3 (*July* 28, 1951).

Measurements are reported which are claimed to show that the rectification (1 Mc/s) is dependent on the volume of material between the electrodes, and not on the area in contact.

537.311.33 : 535.376

Injected light emission of silicon carbide crystals. *See Abstr.* 8654

537.311.33 : 537.322.4

8736. Electrical properties of αFe_2O_3 and αFe_2O_3 containing titanium. F. J. MORIN. *Phys. Rev.*, **83**, 1005–10 (*Sept.* 1, 1951).

Electrical conductivity, Hall effect and Seebeck effect have been measured on two sets of polycrystalline samples of αFe_2O_3 and αFe_2O_3 containing from 0·05 to 1·0 atomic % Ti (*n*-type impurity). One set of samples contained 0·6 atomic % excess of Fe (*n*-type impurity), the second set contained 0·6 atomic % deficiency of Fe (*p*-type impurity). The conductivity of pure αFe_2O_3 is independent of this amount of stoichiometric deviation. The slope of the log conductivity *v.* reciprocal temperature plot is 1·17 eV and the intercept at $1/T = 0$ is $2{\cdot}1 \times 10^4$ ohm^{-1} cm^{-1}. Room temperature conductivity varies from $\sim 10^{-14}$ ohm^{-1} cm^{-1} (extrapolated) for pure αFe_2O_3 to 0·2 ohm^{-1} cm^{-1} for αFe_2O_3 containing 1·0 atomic % Ti. The measured Hall voltages seem to result entirely from magnetization of the samples, which are weakly ferromagnetic, and disappear above the ferromagnetic Curie temperature. The temperature variations of the Fermi level are determined from Seebeck data. The temperature variations of carrier concentration are determined from Fermi level and of mobility from carrier concentration and conductivity for some samples. Carrier concentration results indicate that each added Ti ion donates approximately one electron to the conduction process. Mobilities are found to be less than 2·0 cm^2/V sec, suggesting that conduction involves electrons in the *d* level of Fe. A

537.311.4

8737. The problem of the relation between contact resistance and contact p.d. M. A. KRIVOGLAZ AND K. B. TOLPYGO. *J. Tech. Phys., USSR*, **21**, 417–26 (*April*, 1951) *In Russian.*

Calculation of the tunnel effect through a potential barrier formed by a curvature of the conductivity zone of the semiconductor on which a metal electrode had been deposited. The influence of this effect on the contact resistance is considered for various forms of the potential barrier. In the contact model suggested by B. I. Davydov this influence is particularly strong and leads to "saturation" of the resistance with increasing contact p.d. The image forces on the metal were estimated in a certain approximation and the theory compared with A. M. Pavlenko and V. I. Lyashenko's results obtained in experiments with copper oxide. In the presence of an extraneous field, and when current passes, the curvature of the conductivity zone lower boundary is parallel to the curve of the potential due to extraneous field and space charges and the diffusion equation applies to the current, but not when the field is too strong (i.e. takes values actually occurring on the metal/semiconductor contact faces when work functions differ considerably). At high potentials the main part of the contact resistance is concentrated in a layer 10^{-7} cm thick, and then tunnel effect becomes conspicuous. The treatment is one-dimensional. The Schrödinger equation with a potential term representing the sum of contact potential and periodic lattice potential must be solved, and this is facilitated by the elimination of the lattice potential term by Pekar's method of the effective mass, the solution itself being performed by the *WKB* method. It is very difficult to determine the scatter of the ψ-states obtained on the thermal lattice oscillations, but it is reasonable to assume that in a layer 10^{-7} cm thick only one scatter process occurs, that in the "classical domain" *B* the diffusion equation applies and that in the *A* domain there is only tunnel effect without scatter.

B. F. KRAUS

537.312.5

8738. Photoelectric sensitivity and optical absorption of thallium halide salts. E. K. PUTSEĬKO. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 453–6 (1951) *In Russian.*

A continuation of previous experiments [Abstr. 8748 (1950)] by the condenser method on TlCl, TlBr, TlI in powder form, with constant illumination in addition to the intermittent irradiation previously

used. The spectral distribution of the constant illumination corresponded to the characteristic sensitivity of the semiconductor. The method revealed for the TlBr and TlI new narrow maxima of photoelectric sensitivity near the long-wave limit of the characteristic sensitivity, with the difference that this maximum was found for pulverized TlBr, whereas for TlI it was necessary to evaporate the powder in vacuum. In the latter case the maximum seems thus due to a disruption of the homogeneity of the lattice. In addition to the spectral distribution of the internal photo-effect, the optical absorption of these crystals was determined by photoelectrical spectrometer. B. F. KRAUS

537.312.5

8739. Relaxation properties of photoconduction in silver halides. P. V. MEIKLYAR. *J. Exp. Theor. Phys., USSR*, **21**, 42–50 (*Jan.*, 1951) *In Russian.*

The stationary and relaxation photoconduction (pc.), of AgBr and AgCl mono-crystals, specially prepared for minimum photo-chemical sensitivity, were experimentally investigated. The initial rise in pc. on incidence of illumination of stationary value I, was exponential in character, time constant of the order of 3 msec, followed by a much slower exponential rise of time constant from 10 sec to 30 sec. On cessation of I the rate of decay in pc. was analogous, but rather hyperbolic than exponential. The speed of the initial rapid change increased linearly with I for small values, approaching proportionality to $\sqrt{I}$ for large values of I. Cessation of I before stationary pc. had been reached resulted in a more rapid initial relaxation, but little or no effect on the longer, slower, "tail." These results are discussed in terms of the time of life and mobility of photo-current carriers, and their bearing on photographic phenomena such as departure from the reciprocal law, etc., is emphasized. F. QUELON

537.312.5 : 535.215

8740. Current amplification by [a] silicon p–n junction. Y. KANAI. Note in *J. Phys. Soc. Japan*, **6**, 211–12 (*May–June*, 1951).

A Si ingot was doped with P and a plate containing a p–n junction was cut from it. Large values of current gain were found when the junction acted as an emitter and a probe on the n-region as collector, and vice versa. C. A. HOGARTH

537.312.5 : 621.383.2

8741. An image converter to extend the useful range of photo-multipliers to longer wavelengths. E. R. HOLIDAY AND W. WILD. *J. Sci. Instrum.*, **28**, 282–3 (*Sept.*, 1951).

The range has been extended into the near infra-red (1·2 μ). By the use of a Ni-treated ZnS phosphor the time response of the image converter is sufficiently rapid to cause only small distortion of a 400 c/s square wave. Moreover the blue fluorescence of this phosphor is well suited to the wavelength response of the photomultipliers. A.

537.312.62

8742. Superconductivity of tin isotopes. J. M. LOCK, A. B. PIPPARD AND D. SHOENBERG. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 4) 811–19 (1951).

Detailed measurements have been made of the superconducting transition temperatures and critical magnetic fields of the Sn isotopes of mass 116, 120 and 124. The transition temperature varies with isotopic mass according to the law $T_c \propto M^{-n}$, with $n = 0{\cdot}462 \pm 0{\cdot}014$, a result very similar to that already found in Hg. The critical field curves of isotopes 116 and 124 are geometrically similar, in the sense that both may be represented by the same equation, $H_c/H_0 = f(T/T_c)$, with the same ratio H_0/T_c for both. It is deduced that the electronic specific heat in normal Sn varies only slowly, if at all, with isotopic mass. The variation of T_c and H_0 with M is very close to that predicted by Fröhlich and Bardeen. A.

537.312.62

8743. On the interaction of conduction electrons with lattice vibrations. S. D. DRELL. Letter in *Phys. Rev.*, **83**, 838 (*Aug.* 15, 1951).

Criticizes some aspects of the Bardeen–Fröhlich theory of superconductivity. The energy of the interacting electrons is calculated by means of a Bloch–Nordsieck type canonical transformation, rather than by perturbation or variation methods. It is concluded that these electrons do not possess a small effective mass resulting from interactions with the lattice, and that Fröhlich's shell distribution is not energetically favourable. E. P. WOHLFARTH

537.312.8 : 536.48

8744. The electrical resistance of silver-manganese alloys at low temperatures. II. The resistance in a magnetic field. A. N. GERRITSEN AND J. O. LINDE. *Physica*, **17**, 584–95 (*June*, 1951).

The electrical resistances of dilute Ag–Mn alloys have been investigated at low temperatures and in a magnetic field. The new results do not appear to contradict the suggestion [Abstr. 8127 (1951)] about the existence of a Mn d-level at a distance from the Fermi energy which might be of the same order of magnitude as the thermal energy at liquid He temperatures. The results show a remarkable decrease of the resistance in a magnetic field and at the lowest temperature, and also that the differences between the resistivity in a transverse and in a longitudinal field seem to vanish at the absolute zero. A.

537.322 : 621.313.2–8 : 621.362

8745. Some experiments with Peltier effect. W. C. WHITE. *Elect. Engng, N.Y.*, **70**, 589–91 (*July*, 1951).

The possibility of using the Peltier effect in a thermoelectric power generator has recently become of interest and the phenomenon is discussed from this point of view. Using a couple made from a Bi–Sb and a Bi–Sn alloy a cooling effect of 10°C was obtained. The efficiency of such elements is very low and at the present time there is no possibility of developing any sort of generator or refrigerator.

E. H. DOCK (R)

537.324

8746. Reference tables for thermocouples. H. SHENKER, J. I. LAURITZEN, JR AND R. J. CORRUCCINI. *Circ. Nat. Bur. Stand., Wash.* (*No.* 508) 71 *pp.* (1951).

The tables give electromotive force (absolute millivolts) against temperature (°F and °C in 1 deg. steps); and temperature (°F and °C) against e.m.f. in 0·01 mV

steps (except Cu-constantan which is in 1 mV steps) for the following: Pt *v.* Pt–10% Rh; Pt *v.* Pt–13% Rh; chromel-alumel; Cu-constantan. And e.m.f. against temperature (°F and °C in 10 deg steps) for chromel-constantan.

537.363 : 545.3

Ionography: some aspects of ion migration on paper in an electric field. *See Abstr.* 9105

537.363 : 545.3

Two-dimensional electrophoresis and ionophoresis. *See Abstr.* 9106

ELECTRIC DISCHARGES 537.52

537.521

8747. Electric breakdown in CO_2 from low pressures to the liquid state. D. R. Young. *Overseas Res. Rep.* 233/51; [*Dep. Sci. Industr. Res., Lond.*]; *Off. Tech. Serv., Wash. PB* 110313.

Paschen's similarity law is verified for low pressures. At high pressures small departures were observed for long gap lengths, and large departures for small gap lengths. Simultaneously the scatter of the breakdown voltage became independent of illumination and the breakdown strength dependent on the cathode material; this appeared due to the onset of field emission. Measurements of pre-breakdown currents yielded values for Townsend's first coefficient as well as for the field emission constants. For small gap lengths the pre-breakdown currents were higher than the normal field emission equation predicts, indicating some new process effective at short gap lengths. It was found that the transition from the gaseous to the liquid state does not produce a discontinuous change of the breakdown voltage.

537.523.4

8748. Afterglows in hydrogen discharges. P. Ravenhill and J. D. Craggs. Letter in *Proc. Phys. Soc., Lond. B*, **64**, 618–19 (*July*, 1951).

Describes the detection with a photomultiplier/c.r.o. technique of electron/ion recombination radiation during, and in the afterglow following, atmospheric pressure sparks in hydrogen. J. D. CRAGGS

537.523.4

8749. Cold emission of electrons in spark gaps. F. Llewellyn Jones and E. T. de la Perrelle. Letter in *Nature, Lond.*, **168**, 160–1 (*July* 28, 1951).

Describes a study of the cold emission of electrons from the cathodes of short spark gaps, made by analysis of time-lag data. The results (i/V relation, etc.) suggest that cathode oxide layers are the sources of (field emission) electrons responsible for the initiation of breakdown. J. D. CRAGGS

537.523.5

8750. Stability of short arcs in oxygen, hydrogen, and helium. W. M. Brubaker. *Phys. Rev.*, **83**, 979–81 (*Sept.* 1, 1951).

An arc drawn between separating contacts is known to be very unstable, in the absence of oxygen, in the usual power circuit. To study this instability, experiments have been made in which a four-ampere arc in a 125 V d.c. resistive circuit was repeatedly restruck between separating contacts. Various metals were used as cathodes, with spectroscopically pure carbons as anodes, in various gases. Data have been obtained showing the dependence of average arc duration after ignition on the cathode material and on the pressure and kind of surrounding atmosphere for a number of metals in O_2, H_2 and He. Oxygen exhibits an extraordinary stabilizing influence for most metals, whereas in H_2 the mean life of the arc is generally less than ten milliseconds even at atmospheric pressure. A.

537.525

8751. Determination of the electron temperature in gas discharges by noise measurements. K. S. Knol. *Philips Res. Rep.*, **6**, 288–302 (*Aug.*, 1951).

The use of an electric discharge in a gas as a microwave noise source has been studied. It appears that the noise power available is determined by the electron temperature of the discharge. Certain precautions have to be taken in order to obtain a relatively loss-free matching of the discharge conductance to the waveguide. The electron temperatures of He, Ne, A and Xe are measured as a function of the gas pressure and the direct current. A comparison of these measurements is made with a theoretical formula for the electron temperature as a function of the product of the gas pressure and the radius of the discharge tube. The agreement between theory and experiment is satisfactory. The values of the electron temperature determined in the same discharge tube by noise measurements and by probe measurements are within the limits of accuracy the same. From semi-theoretical arguments a relation is derived between the electron temperature in a gas discharge and the longest resonant wavelength of that gas. A.

537.525

8752. Form of transient currents in Townsend discharges with metastables. J. P. Molnar. *Phys. Rev.*, **83**, 933–40 (*Sept.* 1, 1951).

The form of the current is calculated for a Townsend discharge stimulated by a pulsed light beam, with particular reference to the current component initiated by metastable effects. The calculation is directed particularly to the development of methods for quantitative interpretation of current patterns observed experimentally. A.

537.525

8753. Studies of γ-processes of electron emission employing pulsed Townsend discharges on a millisecond time scale. J. P. Molnar. *Phys. Rev.*, **83**, 940–52 (*Sept.* 1, 1951).

The relative amounts of electron emission from the cathode in a Townsend discharge caused by ions, photons and metastables have been studied experimentally for several cathodes in argon, using pulsed-light stimulation of the discharge. The current initiated by metastables exhibits a slow build-up and decay, thus permitting easy separation from the faster rising effects of gas ionization and electron emission by photons and ions. Time constant studies of the slow component yielded a diffusion constant for

metastable argon atoms of 45 $cm^2\,sec^{-1}$ at one millimeter pressure. The efficiencies of electron emission by metastables and ions was found to be closely the same, while the quantum yield for photon emission was found to be generally smaller. A.

537.525 : 518.3

8754. Rapid determination of gas discharge constants from probe data. L. Malter and W. M. Webster. *RCA Rev.*, **12**, 191–210 (*June*, 1951).

A series of nomograms is presented which make possible the rapid determination of gas discharge constants from double probe data. These constants include plasma density, wall potential, random electron and ion currents. An analysis based upon theory and experiment indicates that the Child–Langmuir space-charge equation is applicable to sheaths with inappreciable error except for the lightest gases and least dense plasmas. A.

537.525.8

8755. Investigation of the fast electrons of a plasma. L. G. Guseva. *J. Tech. Phys., USSR*, **21**, 427–37 (*April*, 1951) *In Russian.*

Experimental investigation of the distribution of the fast electrons on the energies in the positive column of the Hg discharge. To obtain reliable results probes of special design were used, the characteristics of which were determined by preliminary tests and found to cause minimum field distortion. Also, spontaneous electric oscillations were set up in the space between probe and anode by a constant magnetic field. Electrons with energies considerably in excess of the ionization energy were found to have a Maxwell distribution. Characteristic distortions of the electron current curves are due to the presence of space charge layers on the tube walls, the thickness of which represents an appreciable fraction of the column radius. The reliable experimental determination of the number of ions produced by a single electron in unit time is in agreement with the value calculated from T_e and the form of the curve of the effectiveness of ionization. Chaotic voltage oscillations in the circuit containing the discharge gap introduced a certain amount of distortion, but these could be successfully suppressed or reduced to an innocuous minimum by a magnetic field (amplitude of oscillations reduced from 10 to 1 V). The problem of separating electronic from ionic currents in the sonde recordings was solved by an extrapolation method. B. F. KRAUS

537.528 : 621.3.015.5 : 621.317.333.8 : 621.315.612

8756. Some results on the electrical breakdown of liquids using pulse techniques. W. D. Edwards. *Canad. J. Phys.*, **29**, 310–24 (*July*, 1951).

Polar and non-polar organic liquids of relatively simple structure have been used as test liquids. An apparatus was constructed in which the liquid may be distilled and the breakdown measurements made within a completely enclosed system and at pressures less than atmospheric when desired. Single, rectangular pulses of voltage were applied to a pair of highly polished metal spheres immersed in the test liquids. Time delays in breakdown of the order of 1 μsec, the exact value depending on the gap width, have been found for the liquids used. In the liquid state hexane and ethyl alcohol were found to have negative temperature coefficients of breakdown strength. The breakdown strength of benzene was found to depend on the cathode metal but was independent of the anode metal. A reduction in gap width gave rise to an increase in breakdown strength for benzene and *n*-hexane. A.

537.529

8757. Dielectric breakdown in ionic crystals. T. Suita. *Techn. Rep. Osaka Univ.*, **1** (*No.* 1–9) 51–68 (1951).

Studies are made of breakdown strength of the halide crystals, KCl, NaCl and the mixed systems NaCl–AgCl, KCl–NaCl and KCl–KBr, etc., as a function of composition, temperature, nature of field and presence of X-ray irradiation. The general conclusion is that, at higher temperatures, breakdown occurs by electron avalanches but that positive hole motion is also an important factor. G. F. J. GARLICK

537.529

8758. Dielectric breakdown in mixed crystals of KCl and AgCl. T. Suita. Note in *J. Phys. Soc. Japan*, **6**, 202–3 (*May–June*, 1951).

Mixed crystals of KCl and AgCl grown by the Kyropoulous method were examined for dependence of breakdown strength on temperature and time of application of d.c. or a.c. fields. G. F. J. GARLICK

537.529 : 537.226 : 548.0

8759. Current noise and dielectric breakdown in alkali halide crystals. C. Yamanaka and T. Suita. Note in *J. Phys. Soc. Japan*, **6**, 194–5 (*May–June*, 1951).

The sizes of electron avalanches in relation to applied voltage and crystal temperature are investigated using video amplifiers and filters to measure the noise spectrum from which they are deduced.

G. F. J. GARLICK

537.529 : 666.1 : 621.315.612

8760. Breakdown and electric conductivity of glass. K. J. Keller. *Physica*, **17**, 511–30 (*May*, 1951).

See Abstr. 569 (1949). The results are given of investigations on the breakdown field strength F as a function of rise time τ of test voltage and of temperature T. For Thuringian glass at room temperature F increases from 2 to 8 MV/cm with τ decreasing from 10^4 to 10^{-5} sec. At low temperature (−180°C) the breakdown field strength shows only a small dependence on τ for τ from 20 sec to 6×10^{-6} sec. For $\tau = 6 \times 10^{-6}$ sec F is nearly independent of T from −180°C to 0°C; longer rise times give smaller horizontal parts of the (F, T) curves. For $T > 0$°C, F decreases very rapidly both with increasing τ and with increasing T. With the usual assumption that the influence of polarization effects may be neglected, the amount of heat developed before breakdown has been calculated from some preliminary determinations of the pre-breakdown current as a function of field strength. The calculated increase of temperature shows the same order of magnitude as the shift in the direction of the T-axis of the breakdown curves for longer and shorter rise times. The so-called phenomenon of heat-breakdown is discussed. A.

X-RAYS 537.531

537.531 : 535.343

8761. Absorption by aluminium in the soft X-ray region. D. H. TOMBOULIAN AND E. M. PELL. *Phys. Rev.*, **83**, 1196–201 (*Sept.* 15, 1951).

Measurements on the absorption by Al in the spectral range extending from 80 Å to 600 Å have been carried out by the use of a grazing incidence spectrograph. The investigation has revealed that the strong absorption band centred at 129 Å is a "surface" phenomenon which takes place in the metal-substrate interface of absorbers prepared by evaporation. Thin metallic foils without a substrate do not show this absorption band. The present data have yielded consistent results for the mass-absorption coefficient, whose value ranges from $1{\cdot}0 \times 10^4$ cm²/g to $2{\cdot}8 \times 10^4$ cm²/g in the above spectral region. As observed previously in connection with the K edge, a secondary structure is also present on the short wavelength side of the $L_{2,3}$ edge. The L_1 absorption limit has not been detected. A.

537.531 : 535.43

8762. An experimentally determined atomic scattering-factor curve for chromium. J. N. VAN NIEKERK AND F. R. L. SCHOENING. Note in *Acta Cryst.*, **4**, 382 (*July*, 1951).

537.531 : 535.43 : 532.7

8763. Generalization of Born and Green's kinetic theory of fluids to apply to collections of particles of several different kinds. G. FOURNET. *J. Phys. Radium*, **12**, 592–5 (*May*, 1951) *In French.*

In continuation of previous work [Abstr. 7045 (1949)] the classical expression, derived by Zernicke and Prinz for the intensity of X-rays scattered by a collection of identical particles is transformed by means of results contained in the kinetic theory of fluids developed by Born and Green [Abstr. 2792 (1947)]. In the new expression for the intensity, effects due to proximity of the particles and to interparticle forces are separated. An expression, of the type derived by Zernicke and Prinz [*Z. Physik*, **41**, 184 (1927)] is derived for the intensity of the scattered radiation attributable to a collection of particles of several different kinds. J. S. G. THOMAS

537.531 : 535.43 : 532.7

8764. Scattering of X-rays by fluids. G. FOURNET. *Acta Cryst.*, **4**, 293–301 (*July*, 1951) *In French.*

The intensity of radiation scattered in a medium has been expressed by Zernicke and Prins by a probability function $P(r)$ for finding two molecules at distance r; this function contains a purely geometrical description of the state of the system without attempting any explanation. An expression for this intensity based on the kinetic theory of fluids of Born and Green is given; this expression contains the characteristic features of the molecular assemblage, namely, structure factor, intermolecular force potential, average volume per molecule and temperature. The theoretical and the experimental curves for the scattering by argon (gas and liquid) agree in all essential features. A.

537.531.08

8765. Ionometric half value layer meter for measurements of the quality of X-rays. R. H. HERZ. *Z. Naturforsch.*, **6a**, 350–2 (*July*, 1951).

An instrument is described which permits the measurement of the quality of X-rays in terms of the half value layer (HVL) of a suitable filter material. It consists of two ionization chambers adjustable in volume, which are connected in opposition and linked with an X-ray dose measuring device. The chambers are so adjusted that one chamber is twice as sensitive as the other. The filtration of the X-ray beam entering the larger chamber is adjusted until a balance position is reached as indicated by zero deflection of the electrometer needle of the measuring device. A.

537.531.08

8766. Calorimetric determination of the energy flux of 22.5-MeV X-rays. J. S. LAUGHLIN AND J. W. BEATTIE. *Rev. Sci. Instrum.*, **22**, 572–4 (*Aug.*, 1951).

A sensitive method of calorimetrically measuring the energy flux of an X-ray beam is described. Thermistors are employed as the temperature-sensitive elements and are embedded in the irradiated material in a calorimeter. Details and results of the application of this technique to a betatron X-ray beam are described. This method can be applied to X-ray beams of other energies and does not require high intensities. A.

537.531.08 : 616–073.75 : 537.542

A scintillation counter for the relative determination of X-ray intensities in radiological work. *See Abstr.* 8799

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.72

8767. Calculation of optimum focusing of a beam by an electron lens, taking account of space charge. M. D. GABOVICH. *J. Tech. Phys., USSR*, **21** (*No.* 3) 363–8 (1951) *In Russian.*

A method is given of calculating the focal length of the lens, such that the spot on the screen shall have the smallest radius, on the assumption that the lens-screen space is field-free. A graph is given of spot size as a function of screen distance, beam current and accelerating voltage. For the case in which there is a uniform accelerating field between lens and screen, an approx. solution is given, valid when the energy of electrons at the screen is not $\geqslant$ energy on leaving the lens. J. C. E. JENNINGS

537.533.72

8768. On the analytical expressions of the vector potential of a magnetic field with symmetry of revolution. A. MOUSSA AND J. LAFOUCRIÈRE. *C.R. Acad. Sci., Paris*, **233**, 139–41 (*July* 9, 1951) *In French.*

A series expression is given, uniformly convergent outside the cone $z = \pm r$, which may be used to calculate the trajectories of particles in a spectrograph with a symmetry plane. L. PINCHERLÉ

537.533.72

8769. The axial potential in gridded lenses. M. BERNARD. *C.R. Acad. Sci., Paris*, **233**, 298–9 (*July* 25, 1951) *In French.*

An analytic expression for the potential in a lens consisting of two symmetrical electrodes at ϕ_1, separated by a planar grid at ϕ_0. This is: $\phi = \phi_0\{1 + [2(\sigma - 1)G(d,z)/\pi d]\}$ where $G(d,z) = 0{\cdot}587 \log \{[\cosh 1{\cdot}315\,(x + d)]/[\cosh 1{\cdot}315\,(x - d)]\}$, $\sigma = \phi_1/\phi_0$ and $2d$ = distance between planes. The holes in the planes are circular, equal and of unit radius.

A. H. W. BECK

537.533.72 : 621.385.833

8770. Theory of the three-electrode electrostatic lens. I. E. REGENSTREIF. *Ann. Radioélectricité*, **23**, 51–83 (*Jan.*, 1951) *In French.*

A complete derivation of the results announced in Abstr. 7296, 7298 (1950). The theory is generalized covering both lens and mirror and starts from an analytical expression for the axial potential. This part gives the results for the parameters of the lens with thin electrodes in the Gaussian approximation.

A. H. W. BECK (R)

537.533.73

8771. The diffraction, by benzene vapour, of electron beams accelerated through 200 kV. S. YAMAGUCHI. Note in *Naturwissenschaften*, **38** (*No.* 10) 234–5 (1951) *In German.*

Previous investigations on the diffraction of electron by benzene vapour have been carried out with 30–40 kV electron beams and have yielded patterns consisting of 6 or 7 diffuse rings. In the work described here 200 kV beams have been used and patterns showing 12 more well-defined rings have been obtained. Increased accuracy is therefore claimed for the results which in the case of the outer rings indicate interatomic spacings greater than those previously found.

M. R. HOPKINS

537.533.74

8772. The influence of the dissociation of the nucleon on the elastic scattering of electrons. G. S. SAAKYAN. *J. Exp. Theor. Phys., USSR*, **20**, 871–6 (*Oct.*, 1950) *In Russian.*

On account of the virtual decay of nucleons into mesons ($P \rightarrow N + \mu^+$; $N \rightarrow P + \mu^-$) the differential cross-section of elastic scattering of electrons decreases with energy $E_v \geqslant 100$ MeV for large angles. Measurement of this effect leads to some knowledge of the meson field near the proton. An examination of the effect is carried out on the basis of Mott's formula made more precise by inclusion of the energy imported to the nucleon.

J. JACOBS

537.533.74

8773. Calculation of highest approximations of the scattering of fast electrons by electrons. ZH. S. TAKIBAEV. *J. Exp. Theor. Phys., USSR*, **20**, 898–904 (*Oct.*, 1950) *In Russian.*

Using classical electrodynamics a formula is derived for the energy imparted to a δ-electron in the 4th approximation.

J. JACOBS

537.533.74

8774. On the accuracy of the Molière function. I. J. NISHIMURA AND K. KAMATA. Letter in *Progr. Theor. Phys.*, **6**, 262–3 (*March–April*, 1951).

The electron distribution is calculated under approximation B, and the results compared with Molière's [Abstr. 609 (1949)].

E. P. GEORGE

537.533.75

8775. A comparative study of the absorption of monoenergetic positrons and electrons. K. A. BASKOVA AND B. S. DZHELEPOV. *Dokl. Akad. Nauk, SSSR*, 77 (*No.* 6) 1001–2 (1951) *In Russian.*

The energy was defined by standard semi-circular focusing. Positrons are found to have a range $\sim 20\%$ greater than electrons of the same energy.

E. P. GEORGE

537.533.75

8776. Range of high energy electrons in aluminium. H. E. JOHNS, J. R. CUNNINGHAM AND L. KATZ. *Phys. Rev.*, **83**, 952–4 (*Sept.* 1, 1951).

An electron beam was extracted from a 25 MeV betatron by using a magnetic peeler. The high energy electron beam was analysed by bending it through an angle of 90° with a magnetic field. The electrons were passed in turn through a flat ionization chamber, the Al absorber and a second ionization chamber. By measuring the ratio of the two ionization currents for different thicknesses of the absorber, the range of the electrons was determined. The ranges of electrons having energies from 12 to 16 MeV were obtained in this way and found to be in agreement with an empirical formula previously proposed by one of the authors.

A.

537.533.8

8777. The application of Wooldridge's theory of secondary emission. E. M. BAROODY. Letter in *Phys. Rev.*, **83**, 857 (*Aug.* 15, 1951).

A correction to Wooldridge's equation in Brophy's letter [Abstr. 6263 (1951)] leads to a different rate of decrease of the secondary emission ratio at high energies.

J. A. FRANKS

537.533.9

8778. Z dependence and angular distribution of bremsstrahlung from 17-MeV electrons. L. H. LANZL AND A. O. HANSON. *Phys. Rev.*, **83**, 959–74 (*Sept.* 1, 1951).

The relative bremsstrahlung cross-section for the upper portion of the spectrum as a function of Z, for 17 MeV electrons from a 22 MeV betatron, has been measured. The radiation was detected by means of the $Cu^{63}(\gamma,n)$ induced activity, which has a 10·9 MeV threshold. The effect of atomic screening is small for the quantum energies to which this detector responds, but was taken into account. The results are in agreement with the Bethe–Heitler theory for electron-nuclear interactions within 1%. Electron-electron interactions give 0·75× the intensity for electron-proton interactions, as measured with a Cu detector. The total cross-section for radiative energy loss of electrons has been measured with an ionization chamber. The experimental Z dependence of the relative cross-section indicates that the yield from Au for a given $N(Z^2 + Z)$ is somewhat less

than that from low Z elements. This discrepancy might be accounted for by improved corrections for screening, and by more accurate consideration of the radiation produced by electron-electron impacts. Rough measurements of the absolute cross-section are in agreement with the Bethe–Heitler theory. The intrinsic angular distribution of bremsstrahlung, produced in a small amount of cellophane and air, was measured by film and ion chamber, and was found to fit a $1/[1 + (E\theta/\mu)^2]^2$ distribution. The angular distribution was measured with three detectors, for one Be and several Au targets. The results are in agreement with calculations in which the above intrinsic distribution and Molière's multiple scattering theory are used. The central intensity of bremsstrahlung as a function of target thickness, measured with a small ion chamber, is in approximate agreement with a calculation in which the energy loss of the primary electrons has been taken into account. A.

537.533.9 : 778.34

8779. On the sensitivity of photographic grains to electrons. D. Okrent and A. K. Solomon. *Phys. Rev.*, **83**, 826–33 (*Aug.* 15, 1951).

Three single-grain-layer photographic emulsions have been exposed to a measured quantity of monoenergetic electrons, varying in energy from 7 to 112 keV. Two of the coatings (both chlorobromides) had high background fog, which introduced considerable error in the counting procedure. Also, neither of these films was especially sensitive to electrons. Nevertheless, it could be ascertained that the sensitivity of these coatings was fairly constant up to 50 to 70 keV, after which it dropped off slowly. These two coatings were prepared in almost identical fashion and showed a similar response to white light, yet their sensitivity to electrons differed by a factor of 8 or 9. The third coating was a fine-grained bromoiodide, similar to the emulsions used in nuclear track plates. This coating was essentially fog-free, and reproducible results were obtained. The sensitivity was highest at low electron energies (approaching unity), dropping rapidly at first, then levelling off for higher energies. The curve of developability probability as a function of electron energy bears a close resemblance to the curve of space rate of energy loss for the electron. It also is in fairly good agreement with curves based on grain count data for electron tracks reported by Ross and Zajac. It was estimated that at 112 keV the electron forms about 62 ion pairs in passing through the centre of a grain in this third coating. Since the sensitivity is still appreciable at this energy, this number of ion pairs should roughly represent a quantity which is approaching the lower limit of the number required to render the average grain in this coating developable. This is to be compared with the data that Webb has published, namely, that about 40 quanta of light are needed on the average to render a photographic grain developable. A.

537.534 : 621.384.6

8780. Forced betatron oscillation in a synchrotron with straight sections. N. M. Blachman. *Rev. Sci. Instrum.*, **22**, 569–71 (*Aug.*, 1951).

The effect of azimuthal variation in the height of the magnetic median plane on the vertical oscillations of a particle in a synchrotron having four straight sections is studied, particularly in the neighbourhood of resonance between the frequency of these oscillations and the frequency of revolution. It is found that Fourier analysis, which is needed in the case of a circular magnet, is replaced by analysis using modified sine and cosine functions. This investigation also applies to the effect on the radial betatron oscillations of azimuthal variation in the equilibrium radius. A.

537.534 : 621.384.6

8781. A dee biasing system for a frequency modulated cyclotron. L. L. Davenport, L. Lavetelli, R. A. Mack, A. J. Pote and N. F. Ramsey. *Rev. Sci. Instrum.*, **22**, 601–4 (*Aug.*, 1951).

The requirements that must be met by a satisfactory dee biasing system are outlined. A successful and simple means of meeting these requirements is described.

537.534 : 621.384.61 : 621.396.615.17

8782. Pulser for cyclotron oscillator. W. H. Henry and J. D. Keys. *Canad. J. Phys.*, **29**, 137–41 (*March*, 1951).

In the direct exposure of photographic plates or in studies of very short activities it is frequently necessary to operate the cyclotron for short periods. In order that such periods be reproduced with accuracy a pulser has been built for controlling the r.f. oscillator of a synchrocyclotron. Previous pulsers reported have either used a mechanical device to produce the triggering pulse, or have shut off the oscillator for a certain period of each f.-m. cycle by grid blocking. In the operation of the present pulser the oscillator is normally not oscillating, and is accurately triggered on at the desired frequency of the f.-m. cycle by the absorption of power from a low-power oscillator by the dead tank circuit. A.

537.534.72

8783. Use of trajectories asymptotic to stationary orbits for separation of high momentum particles. J. Thibaud and J. Lafoucrière. *J. Phys. Radium*, **12**, 642–51 (*June*, 1951) *In French.*

A review of the arrangements used in the authors' magnetic spectrographs with special reference to a new method specially suited to the study of high Hp particles. H. J. H. Starks

537.534.72

8784. Suggested automatic trajectory tracer for charged particles. J. Salmon. Letter in *J. Phys. Radium*, **12**, 694–5 (*June*, 1951) *In French.*

The theory and construction of a possible apparatus employing a single servo-motor are briefly described. H. J. H. Starks

537.534.74

8785. Multiple Coulomb scattering of high energy [337 MeV] protons in photographic emulsions. M. J. Berger, J. J. Lord and M. Schein. Letter in *Phys. Rev.*, **83**, 850 (*Aug.* 15, 1951).

"Co-ordinate" measurements yield a scattering constant of $24{\cdot}1 \pm 0{\cdot}8$ for 100 micron cell lengths. J. J. Wilkins

537.534.74

8786. Experiments on proton-proton scattering from 120 to 345 MeV. O. CHAMBERLAIN, E. SEGRÈ AND C. WIEGAND. *Phys. Rev.*, **83**, 923–32 (*Sept.* 1, 1951).

The differential scattering cross-section for elastic collisions of 345 MeV protons with protons has been measured in the angular range 11° to 90° (centre of mass system). The same cross-section has been measured over more limited ranges of angles at lower energies. The cross-section (in the centre of mass system) at 90° is remarkably independent of energy. The cross-section at 345 MeV is very independent of angle, being close to $3{\cdot}8\times10^{-27}$ cm²/steradian (centre of mass system). The agreement with existing phenomenological theories based on static potentials is rather poor, especially in the case of scattering at small angles at 345 MeV. A.

537.534.74 : 778.34

8787. Method of distinguishing 2-pronged stars in nuclear emulsions. M. MERLIN AND O. PIERUCCI. *Nuovo Cim.*, **8**, 528–33 (*Aug.*, 1951) *In Italian.*

The method is based on the fact that, apart from the case of very low energies, all two-pronged events with a scattering angle of at least 120° can be practically considered as stars. By assuming isotropic distribution for evaporation prongs, the total number of two-pronged stars can be obtained by extrapolation. It has been verified that the other two-pronged events, mainly due to a single Coulomb scattering, satisfy the Rutherford formula. A.

537.534.75

8788. On the range of polonium α-rays in several alkali halide crystals (NaCl, KCl, KBr and KI). L. WIENINGER. *Acta Phys. Austriaca*, **4** (*No.* 4) 355–9 (1951) *In German.*

Po-α-particle ranges are measured in several crystals from the region of discoloration of the crystal and the molecular stopping-power deduced. The stopping powers of the individual atoms are then obtained, that for Cl being assumed. R. H. DALITZ

537.534.75 : 778.3

8789. Alpha-particle range-energy curve for Kodak NTA emulsion. F. E. STEIGERT, E. C. TOOPS AND M. B. SAMPSON. Letter in *Phys. Rev.*, **83**, 474 (*July* 15, 1951).

A calculated range-energy relationship for alpha particles of energies up to 15 MeV has been verified experimentally and is in good agreement with Rotblat's data for the Ilford C2 emulsion. [Abstr. 6270 (1951)]. A. C. COATES

537.534.75 : 778.3

8790. Proton range-energy relation for Eastman NTA emulsions. H. T. RICHARDS, V. R. JOHNSON, F. AJZENBERG AND M. J. W. LAUBENSTEIN. *Phys. Rev.*, **83**, 994–5 (*Sept.* 1, 1951).

The ranges of protons recoiling from monoergic neutrons have been used to determine a range-energy relation for Eastman NTA emulsions. The experimental results for proton energies from 1 to 17 MeV agree closely with Webb's computed range-energy relation.

DISCHARGE TUBES . COUNTERS 537.54

537.542

8791. On an improved ion source. O. REIFENSCHWEILER. Note in *Z. Naturforsch.*, 6a, 331–2 (*June*, 1951) *in German.*

Describes the performance of a Thonemann-type ion source with an electrostatic focusing system fitted immediately below the ion beam canal. 520 μA maximum beam current was obtained. The effect of varying the various source voltages, etc., is described. J. D. CRAGGS

537.542

8792. On the calculation of pulse-size and dead-time of Geiger counters. I. A. KRYUKOV. *J. Exp. Theor. Phys., USSR*, **20**, 842–53 (*Sept.*, 1950) *In Russian.*

Formulae for pulse-size and dead time are developed, and compared with experiment. It is deduced that the electron-collection time lies between 0·5 and 2 μsec, depending on conditions. The experimental data may be satisfactorily explained assuming a constant positive ion mobility, and taking into account the time for electron collection. E. P. GEORGE

537.542

8793. Pressure dependence of sensitivity of photoelectron counters. R. ITO. *J. Phys. Soc. Japan*, **6**, 188–91 (*May–June*, 1951).

The response of H_2 filled G.M. tubes in the short u.v. region is shown to increase sharply as the H_2 pressure is reduced to less than 2 mm Hg. This behaviour is interpreted theoretically in terms of intrinsic photoelectric efficiency and the probability of counting emitted electrons, the latter being affected by back diffusion. G. F. J. GARLICK

537.542

8794. Loop-line windowless flow Geiger counter. P. E. DAMON. *Rev. Sci. Instrum.*, **22**, 587–9 (*Aug.*, 1951).

The instrument described is of simple and robust design. The anode is a wire loop, and the cathode includes an earthed line wire which electrically shields the sample. The line wire, when properly placed, provides greater stability and freedom from spurious effects due to the accumulation of a charge on the sample. The geometry is essentially 2π. The instrument may be used for the counting of alpha- as well as soft beta-particles. It is self-shielded. A.

537.542

8795. Some aspects of the counting properties of diamond. G. P. FREEMAN AND H. A. VAN DER VELDEN. *Physica*, **17**, 565–72 (*June*, 1951).

See Abstr. 8000 (1950). The use of a new diamond specimen leads to the same value for the product of the mobility and the mean free time in the crystal as for the previous specimen. The energy necessary for the liberation of one electron appears to be 8·6 eV or less. Evidence is given that the parts of a mixed crystal used for the counting of α-particles are of type II (transparent to ultraviolet light). A.

537.542 : 621.387.462

8796. Integrating crystal detectors for high energy photons and particles. R. S. ALGER. *Overseas Res. Rep.* 229/51 [*Dep. Sci. Industr. Res., Lond.*]; *Off. Tech. Serv., Wash., PB* 110307.

Describes an investigation of LiF, KBr, and NaCl as integrating detectors for high-energy photons and particles. Dosage measurements were based on the number of colour centres formed in single crystals under X- and cathode-ray bombardment. Exposures of 20 to 10^4r (30 kV X-rays) were measured photoelectrically and 10^5 to 10^7r (3 MeV X- and cathode-rays) were measured optically. The crystals are said to have advantages in measurements where wide range, high absorption, small size and simplicity are desirable, but their use is restricted by the length of bleaching period required between exposures.

537.542

8797. Studies with scintillation counters. W. HANLE AND H. SCHNEIDER. *Z. Naturforsch.*, **6a**, 290–3 (*July*, 1951) *In German.*

The most favourable amplifier bandwidth for scintillation counters is discussed. Measurements of the luminescence of organic solids and liquids excited by particles are described. G. F. J. GARLICK

537.542

8798. A scintillation counter for thermal neutrons. J. E. DRAPER. Letter in *Rev. Sci. Instrum.*, **22**, 543 (*July*, 1951).

Two types of scintillator are used, one consists of a thin layer of B_2O_3 powder immersed in terphenyl/toluene "counting liquid" and the other of Li I (Tl I) crystals in a sealed, evacuated Pyrex tube. Both are employed in conjunction with a photomultiplier, and both detect about half of all thermal neutrons crossing the counting volume when a counter thickness of one neutron mean free path is used. J. THEWLIS

537.542 : 537.531.08 : 616–073.75

8799. A scintillation counter for the relative determination of X-ray intensities in radiological work. M. TER-POGOSSIAN AND W. B. ITTNER, III. *Rev. Sci. Instrum.*, **22**, 646–8 (*Aug.*, 1951).

An instrument is described for determining accurately the intensity of an X-radiation by direct reading. This instrument consists in a small KI crystal which fluoresces under the action of high energy photons. The light thus emitted is "piped" by means of a Lucite rod to a photomultiplier tube. The current generated in the tube is measured by a microammeter. A series of tests on the energy dependence of this detector is reported. It is concluded that the instrument described is suitable for the determination of isodose charts. A.

537.542 : 539.16.08 : 616–073.75

8800. Scintillation detector for the localization of radioactive concentrations *in vivo*. W. B. ITTNER, III, AND M. TER-POGOSSIAN. *Rev. Sci. Instrum.*, **22**, 638–41 (*Aug.*, 1951).

A radiation detection instrument, employing a large naphthalene-anthracene crystal and a concentric conical collimator, for the localization of radioactive concentrations at a distance is described. A simplified method of obtaining the general outline of volumetric distributions of radioiodine is presented. A.

537.542 : 539.16.08

8801. An automatic plate counter. J. L. LERNER AND D. F. UECKER. *Rev. Sci. Instrum.*, **22**, 575–7 (*Aug.*, 1951).

A versatile counter that automatically sorts sample plates into several groups according to the radioactivity of the plates is described. Details are given for a counter specifically intended to minimize the tedious job of counting decontaminated plates for background. A.

537.542 : 621.317.35 : 621.385.15

8802. Pulse spectrograph. A. DALLOS. *Acta Phys. Hungarica*, **1** (*No.* 1) 56–65 (1951).

A simple method is described for determining the amplitude distribution of pulses arising in the anode circuit of an electron multiplier. The rise and decay times are $< 10^{-9}$ and 10^{-6} sec respectively, but by means of pulse-lengthening circuits, incorporating a multivibrator triggering circuit, the pulses can be made visible on a c.r.t. using a linear sawtooth sweep and grid modulation. The vertical deflection is controlled by the same circuits and is $\propto$ the pulse amplitude. The distribution is evaluated by placing an opaque screen with a horizontal slit in it in front of the c.r.t. and a photomultiplier tube in front of the slit. Readings are then taken of the tube output current as a d.c. bias, applied to the Y-plates of the c.r.t., is varied. If the pulse rate is high, e.g. 10^5 pulses/sec, a sawtooth voltage is substituted for the d.c. bias and this voltage is also applied to the X-plates of a second c.r.t. while the Y-plates are fed from the amplified output of the measuring photomultiplier tube. The trace on the second tube is the amplitude distribution curve required. A quick and accurate method of evaluation for slow-rate pulses is also described. It is shown that, if a long photographic exposure, e.g. 10 min., is taken of the whole of the first c.r.t. screen when a quadratically time-dependent linear sweep is used, the contour of the illuminated portion on the photograph depicts the amplitude spectrum. H. G. M. SPRATT

537.542 : 621.385 : 621.318.572

8803. The use of gated-beam tubes in coincidence circuits. B. SMALLER AND E. AVERY. Note in *Rev. Sci. Instrum.*, **22**, 341 (*May*, 1951).

The pulse duration from the photomultiplier when organic phosphors are used with scintillation counters is $\sim 10^{-8}$ or 10^{-7} sec. The circuit described, which has a comparable resolving time, uses a univibrator as a pulse shaper with the gated-beam tube as a coincidence mixer. The discrimination ratio of coincidence to single events (mixer output pulse height) is $>100 : 1$. A. J. KENNEDY (R)

537.543 : 621.3.014.1 : 621.385.2

8804. Effect of variable mass of the electron on the space-charge limited current in a diode. S. VISVANATHAN. *Canad. J. Phys.*, **29**, 159–62 (*March*, 1951).

The change in the current-potential distribution due to the relativistic variation of the mass of the electron has been calculated by suitable series expansions in the case of a plane-parallel diode and has been shown to be considerable in the case of large power tubes. A.

IONIZATION . THERMIONICS 537.56/.58

537.56 : 539.153

8805. Average excitation potentials of air and aluminium. M. BOGAARDT AND B. KOUDIJS. *Physica*, **17**, 703–10 (*July*, 1951).

By means of a graphical method the average excitation potential I may be derived from experimental data. Average values for I_{air} and I_{Al} have been obtained. It is shown that in representing range/energy relations by means of Bethe's well-known formula, I has to be taken as a continuously changing function of the energy of the incident particle. A.

537.563

8806. Negative ions in the gaseous discharge in the vapours of halides of the alkali and alkaline earth metals. V. M. DUKELSKIĬ, E. YA. ZANDBERG AND N. I. IONOV. *J. Exp. Theor. Phys., USSR*, **20**, 877–86 (*Oct.*, 1950) *In Russian.*

The composition of negative ions formed during gaseous discharge has been analysed mass-spectrographically. The existence of Li^-, Na^-, K^-, Rb^- and Cs^- has been established. No Mg^- or Ca^- ions could be detected as a result of discharge in the vapours of $MgCl_2$ and $CaCl_2$ respectively. Molecular negative ions MeX^- and MeX_2^- were observed for alkali halides, and ions MeX^-, MeX_2^- and MeX_3^- for $MgCl_2$ and $CaCl_2$. The discharge in AgI vapour revealed negative atomic ions of Ag. F. LACHMAN

537.583

8807. Thermionic emission from (Ba–Sr)O cathodes illuminated by the incandescent lamp. T. HIBI AND K. ISHIKAWA. Letter in *Phys. Rev.*, **83**, 659 (*Aug.* 1, 1951).

Describes experiments showing enhanced thermionic emission with build up and decay from a heated cathode when intensely illuminated. The results are in general agreement with the segregation theory of impurity centres in semiconductors [Abstr. 4383 (1951)] but the earlier estimate of 1·32 eV for the trapping energy of an electron at the impurity centres has to be increased. A. H. W. BECK

537.583 : 548.73

8808. A study of oxide-coated cathode by X-ray diffraction method. E. YAMAKA. Letter in *J. Appl. Phys.*, **22**, 1087–8 (*Aug.*, 1951).

Crystal size was correlated with thermionic emission in a special tube with mica windows. Crystal size is a function of processing temperature and rises rapidly above 1 065°C. Impurity activation was dominant at low temperatures, thermal at high.

A. H. W. BECK

537.585

8809. Increased efficiency of the high power thermionic cell by superposition of a strong h.f. field. S. KLEIN. *C.R. Acad. Sci., Paris*, **233**, 143–5 (*July* 9, 1951) *In French.*

A loud speaker or microphone operating by positive ion emission at atmospheric pressure is described. A Pt wire, coated so as to promote +ve ion emission is sealed into a quartz cylinder at the base of an exponential horn. A modulated h.f. wave, applied between the wire and ground, heats the wire and the modulation causes the device to produce audible or supersonic waves. The response curve is flat to at least 10 kc/s, and there are no moving parts with undesirable resonances. A. H. W. BECK

COSMIC RAYS 537.591

537.591

8810. On the decay of neutral *V*-particles. R. B. LEIGHTON, S. D. WANLESS AND W. L. ALFORD. Letter in *Phys. Rev.*, **83**, 843 (*Aug.* 15, 1951).

Nine measured examples of V^0 decay show all negative particles mesons, one appearing to undergo π–μ decay, and most positive particles protons with probably two examples of lighter positives. The Q-values deduced for the $V^0 \rightarrow p^+ + \pi^-$ reaction are regarded as inconsistent with a unique two-body decay, and the interpretation of the results on the scheme $V^0 \rightarrow$ nucleon $+\pi+\pi$ is examined.

J. G. WILSON

537.591

8811. Cosmic rays at airplane altitudes. A. T. BIEHL AND H. V. NEHER. *Phys. Rev.*, **83**, 1169–74 (*Sept.* 15, 1951).

A continuation of experiments made in a B-29 aeroplane to investigate the properties of cosmic rays is herein reported. Part I describes results on the latitude effect at 30 000 ft measured with counter telescopes and with both shielded and unshielded ionization chambers, from 64° geomagnetic north to the magnetic equator. A considerably larger latitude effect for the shielded ionization chamber than with the unshielded one or with counter telescopes indicates a definite change in the character of the radiation as one goes toward the equator at this altitude. The "knee" of the latitude effect is investigated in detail by a number of similar flights. Part II describes measurements made on density and formation of extended air showers. The apparatus was of such a nature as to be sensitive to relatively sparse showers. The densities obtained can be fitted to an integral power law spectrum with a negative exponent of $1 \cdot 50 \pm 0 \cdot 05$ for an altitude of 30 000 ft. Intensity-altitude curves are presented, showing that the development of smaller showers takes place nearer the top of the atmosphere than does the development of large showers. Derived zenith-angle dependences at various altitudes are also given. A.

537.591

8812. On the origin of the cosmic radiation. G. COCCONI. *Phys. Rev.*, **83**, 1193–5 (*Sept.* 15, 1951).

Experimental evidence of the isotropy of the cosmic radiation of energy above 10^{13} eV is given. The interpretation of this result leads one to infer that the more energetic particles of the cosmic radiation are not of solar origin, but come from the whole galaxy. On the other hand, a local origin seems necessary for the particles of moderate energy (10^9–10^{10} eV). A.

537.591.1

8813. The spectrum of the ionizing particles of the soft and hard components of the cosmic radiation. N. A. Dobrotin, Ya. I. Graevskaya, N. L. Grigorov, S. I. Nikolskiĭ and I. D. Rappoport. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 4) 599–602 (1951) *In Russian.*

The distribution in size of the pulses in an electron-collection ion chamber arising from the passage of single particles was investigated at 3 860 and 2 000 m altitude. Coincidences between the pulses from the ion-chamber and various arrangements of G.M. counters were employed. Up to $1{\cdot}5\times$most probable pulse size, the agreement with Landau's theory is good. The majority of the small number of larger pulses may be explained in terms of showers. The conclusions of Alikhanian *et al.* concerning the existence of a large number of particles of intermediate mass are doubted. E. P. GEORGE

537.591.1

8814. On the disintegration of particles generating electro-nuclear showers. S. A. Azimov, V. F. Vishneskiĭ and N. I. Khilko. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 2) 231–4 (1951) *In Russian.*

The following absorption lengths of the particles were obtained: water 170 ± 10 g/cm², air 123 ± 6 g/cm². The former value was obtained by lowering a counter system 6 m into a lake at 3 900 m altitude. The difference is interpreted in terms of π-mesons.

E. P. GEORGE

537.591.1

8815. Positive excess of mesons at 2 000 metres. P. Bassi, I. Filosofo, C. Manduchi and L. Prinzi. *Nuovo Cim.*, **8**, 469–74 (*July*, 1951) *In Italian.*

Discusses a measurement of positive excess at 2 000 m effected by deflecting the mesons of both signs through the action of a magnetic field of 12 300 gauss. The figures found for the excess are $0{\cdot}18 \pm 0{\cdot}05$ between $4{\cdot}5$ and $5{\cdot}5\times10^8$ eV and $0{\cdot}38 \pm 0{\cdot}06$ between $13{\cdot}5$ and $14{\cdot}5\times10^8$ eV. A.

537.591.15

8816. On the density spectrum of extensive air showers. P. Budini. *Nuovo Cim.*, **8**, 446–65 (*July*, 1951) *In Italian.*

Starting from the assumption, based upon experimental evidence, that the transversal structure of extensive showers is satisfactorily described by the Molière distribution, and considering the genetic model of the electromagnetic component as unspecified within large limits, analytical expressions for the characteristic parameters of the density spectrum are found. Expressions are specialized with reference to the hypothesis of the primary electron; it is found that although by the aid of a proper choice of the energetic spectrum of the primary radiation, it is possible to reach an agreement between theoretical previsions and experimental data at sea level, strong disagreement appears in height, specially with reference to denser showers. A.

537.591.15

8817. A tentative interpretation of the second maximum in the transition curve for cosmic-ray showers. Tsai-Chü. Letter in *Phys. Rev.*, **83**, 867 (*Aug.* 15, 1951).

The second maximum of the transition curve into heavy materials (e.g. Pb) is regarded as a phenomenon of the behaviour of electrons and photons of well below cascade energies. It is suggested that the flux of these can under certain conditions increase for distances of the order twice the absorption range of the most penetrating photons (say ~ 5 cm Pb). The importance of counter sensitivity is stressed.

J. G. WILSON

537.591.3

8818. Experiments comparing absorption in hydrogen and carbon of particles generating electro-nuclear showers. B. I. Verkhovskiĭ, N. A. Dobrotin, I. I. Levintov and G. N. Khodakov. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 6) 1007–10 (1951) *In Russian.*

Penetrating showers were recorded using a system of Pb-shielded counters. The absorption in C and paraffin of the generating particles was measured. The absorption length in C was 108 ± 10 g/cm². The C-paraffin difference was significant, and is used as evidence in favour of multiple production.

E. P. GEORGE

537.591.3

8819. The energy spectrum of the soft (electron) part of cosmic radiation found by absorption in Pb and Al. J. Clay and E. van Alphen. *Physica*, **17**, 711–14 (*July*, 1951).

The absorption of cosmic radiation was measured in Pb and Al. From the difference the differential spectrum of the electron component was found to be $dN = N_0E^{-1\cdot50}\,dE$ up to $E = 10^8$ eV. For energies above 10^8 eV the relation was $dN = N_0E^{-2\cdot5}\,dE$. The value found from the absorption in Fe and C was $dN = N_0E^{-1\cdot35}\,dE$. In a total of 261 particles 52 were electrons and 9 meson particles, which were absorbed in 10 cm Pb. A.

537.591.5

8820. The (time) variation and the origin of cosmic rays. A. Dauvillier. *Cah. de Phys.*, *No.* 35–6, 1–78 (*Jan.–March*, 1951) *In French.*

The time variation and the problems of origin of the primary cosmic radiation are discussed mainly in an historical context, and the early work on both topics is extremely well covered. The work of the last few years is not critically examined. J. G. WILSON

537.591.5

8821. Similarity of initial processes of continuous cosmic radiation and showers. I–II. J. Clay. *Proc. K. Ned. Akad. Wet., Ser. B*, **54**, 20–9 (*Jan.–Feb.*); 210–11 (*May–June*, 1951).

The difference of composition, barometric coefficient, etc., of the continuous cosmic-ray intensity and of extensive and penetrating showers is explained on the view that the latter arise when energetic nucleons penetrate deep into the atmosphere. In the second part, attention is drawn to the similarity of composition between sea-level extensive showers and the total intensity at high altitude.

J. G. WILSON

537.591.5

8822. Barometer effect and daily variation of large air-showers. A. Citron. Note in *Z. Naturforsch.*, **6a**, 334–5 (*June*, 1951) *In German.*

Showers of various densities were studied by selecting various coincidences in five large counter

trays of max. separation 11 m. The bar. coeff. was found to increase with shower density. After reduction to constant pressure, the shower frequency was independent of solar and sidereal time.

E. P. GEORGE

537.591.5 : 551.521.64

8823. Effect of weather upon cosmic radiation according to measurements during 1932/34, at Königsberg (Pr.). H. TIELSCH. *Wiss. Abh., Reichsamt für Wetterdienst*, **4** (*No.* 2) 21 *pp.* (1938) *In German.*

The effect of various meteorological factors upon the intensity of cosmic radiation was investigated by means of an ionization chamber under completely shielded and partially shielded conditions. Sensitivity of apparatus increases with rising room temperature. Increasing barometric pressure, increasing water vapour pressure and increasing depth of snow cover reduce ionization intensity of radiation. Cloudiness increases ionization intensity, insolation diminishes it; maximum intensity of ionization during SW wind, minimum during NW wind. From 1932 to 1934 intensity of radiation declined 1·2% per month. Maximum ionization intensity at 3 o'clock sidereal time and minimum at 15 o'clock. On the basis of Central European Time, ionization intensity is greater during the day than at night. Daily march of ionization intensity is determined by daily march of water vapour pressure. METEOROLOGICAL ABSTRACTS

537.591.8

8824. On the star production by cosmic ray underground. S. MIURA AND S. OGAWA. Letter in *Progr. Theor. Phys.*, **6**, 251–2 (*March–April*, 1951).

The production of stars is discussed with particular reference to nuclear excitation and π-meson production by the electromagnetic field of μ-mesons.

J. G. WILSON

537.591.8

8825. A high pressure cloud chamber observation of cosmic ray at 2 740 m. elevation. Y. WATASE, S. MIYAKE, K. SUGA AND O. KUSUMOTO. Note in *J. Phys. Soc. Japan*, **6**, 204–6 (*May–June*, 1951).

A chamber 24 cm dia. operated at random at 2 740 m, with 75 atm. A had sensitive time about 1·5 sec. Observations over total sensitive time about 30 min are summarized: these include a 3-particle event, probably pair production by an electron. J. G. WILSON

537.591.8

8826. Transition effect of disintegration stars in nuclear plates under thin layers. G. BELLIBONI, L. FABBRICHESI, L. DE MARCO AND M. MERLIN. *Nuovo Cim.*, **8**, 374–82 (*June*, 1951) *In Italian.*

New results are reported on disintegration stars observed in nuclear plates exposed at 4 550 m under thin layers of Pb and Al. The maximum found in a previous experiment at 0·5 cm of Pb and 2 cm of Al for 3- or 4-prong stars is confirmed by the present one. The slope of absorption curves for stars with 5 or more prongs is also clearly higher in the first 2 or 3 cm of absorber than that related to the geometrical cross-section. The possible explanations of these effects are discussed taking into account both the ionization-loss of primary protons and the production of stars by photodisintegration. A.

537.591.8

8827. Meson production in the atmosphere. J. D. PULLAR AND E. G. DYMOND. Letter in *Phil. Mag.*, **42**, 663–4 (*June*, 1951).

Results are given of the counting rate of a 3-fold telescope containing 8 cm Pb flown to 4 mb (124 000 ft) at 59°N geomagnetic. After correcting for showers, there is a maximum counting rate at 35 mb.

E. P. GEORGE

537.591.8

8828. A penetrating component secondary to normal [μ] mesons. R. MAZE. *C.R. Acad. Sci., Paris*, **232**, 2421–3 (*June* 25, 1951) *In French.*

Coincidences between two twofold trays of counters, each counter separated from its neighbours by 1 cm Pb, with varying absorber above the apparatus and between the trays, have been observed at sea-level and at 30 m water equivalent underground. Evidence is given for the production by mesons of secondaries more penetrating than electrons and photons. J. G. WILSON

537.591.8

8829. The emission of radioactive nuclei in cosmic ray stars. E. PICKUP AND L. VOYVODIC. *Canad. J. Phys.*, **29**, 263–73 (*July*, 1951).

It has been found that a certain proportion of the fragments emitted in cosmic-ray stars formed at about 85 000 ft consists of radioactive nuclei, i.e. in electron sensitive photographic emulsions, tracks of electrons with energies of several MeV can be seen originating at the end of the track of the fragment. Details of such events are given, together with energy measurements for the disintegration electrons made by the multiple Coulomb scattering method. The significance of the results, and possible identification of the fragments, are discussed. A.

537.591.8

8830. Neutrons produced in the atmosphere by the cosmic radiations. J. A. SIMPSON. *Phys. Rev.*, **83**, 1175–88 (*Sept.* 15, 1951).

The distribution of disintegration product neutrons in the atmosphere has been measured from the geomagnetic equator to 65°N and up to ~ 220 g.cm^{-2} air. The measured exponential absorption of the neutron producing radiations in the equilibrium portion of the atmosphere is: $L(0°) = 212$, $L(19°) = 206$, $L(40°) = 181$, $L(53°) = 157$, $L(65°) = 157$ g.cm^{-2}. It is shown that the neutron component has the largest latitude effect of any known secondary component in the cosmic rays and that the neutrons are part of a low energy nucleonic component in the atmosphere. The yield of neutrons per incident primary particle in an air column one cm^2 area extending through the atmosphere has been calculated at various latitudes. The yield increases by 400% between 0° and 55°N. The slow neutron absorption in air at the geomagnetic equator under 312 g.cm^{-2} air was measured. It is concluded that nucleon collision chains in the atmosphere are the principal process by which a low energy nucleonic and neutron component is produced. Measurements at high latitudes over a period of two years have shown that fluctuations and large changes of intensity of the neutron component may occur during solar and terrestrial disturbed days. A.

MAGNETISM 538

538.082.1, 538.221

8831. Null-coil pendulum magnetometer; Magnetic and electrical properties of natural and synthetic single crystals of magnetite. C. A. Domenicali. *Overseas Res. Rep.*, 231/51 [*Dep. Sci. Industr. Res., Lond.*]; *Off. Tech. Serv., Wash., PB* 110315.

The first report (17 pp., Oct., 1949) describes a magnetometer for the measurement of magnetization of small single crystals or polycrystalline specimens of ferromagnetic materials. It may also be used for measurements on para- and dia-magnetic material. The specimen is placed in an inhomogeneous magnetic field inside a "null coil" of known geometry, and the current through the coil is adjusted to reduce the net magnetic moment of coil and specimen to zero. This coil is rigidly attached to the lower end of a sensitive pendulum, and the null-position of the pendulum is observed with the aid of a projection microscope.

The second (29 pp., Oct., 1949) describes an investigation of the magnetic and electric properties of magnetic single crystals in static fields, the dependence of these properties on temperature, and in particular the behaviour in the vicinity of the low-temperature transition. The Barkhausen effect, the longitudinal saturation magnetostriction, and the thermal expansion of magnetic single crystals were also investigated, and the results are reported.

538.082.101

8832. The measurement of magnetic constants by the Faraday method. C. Courty. *C.R. Acad. Sci., Paris*, **233**, 137–9 (*July* 9, 1951) *In French.*

See Abstr. 7060 (1951). An experimental investigation of the variation with v of the constant k in the formula $\delta = kv(\chi - \chi_0)$, where δ is the angle of torsion, v the volume of the specimen, and χ, χ_0 the susceptibility of the specimen and the surrounding medium. Mean values for some diamagnetic liquids are given. E. P. WOHLFARTH

538.11 : 530.145

8833. The energy loss of free magnetic poles in passing through matter. E. Bauer. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 4) 777–88 (1951).

Dirac has shown that in quantum theory free magnetic poles are possible only if their pole strength g is an integral multiple of $\hbar c/(2e) = 137e/2$. The ionization produced by such particles is calculated by the classical impact parameter method and also by quantal perturbation theory; at sufficiently large velocities the rate of loss of energy of poles of unit strength is $g^2/e^2 \simeq 5\,000$ times as large as that of an electron of the same velocity; at low velocities the energy loss of a monopole decreases steadily without rising to a maximum as in the case of electric particles. The mass of magnetic poles is not predicted by Dirac's theory, but poles of electronic mass m_e could hardly have escaped detection because of the magnitude of radiation reaction. For poles of mass $g^2/e^2 m_e$ the energy loss due to Bremsstrahlung is g^2/e^2 times as large as that of electrons of the same velocity. The elastic scattering of such poles is considered in some detail, using perturbation theory; the scattering cross-section of poles of velocity v is $(gv/ec)^2$ times that for electrons of the same velocity. The tracks to be expected from such particles in detecting devices for cosmic rays would be rather similar to those of heavy nuclear fragments. A.

538.11

8834. The temperature dependence of [the] magnetization of ferrites on the basis of the theory of ferromagnetism. H. Watanabe. Note in *J. Phys. Soc. Japan*, **6**, 212–13 (*May–June*, 1951).

Gives results of calculations (based on Néel's theory) of the temperature dependence of the saturation magnetization and of the dependence on composition of the Curie temperature for mixed Ni–Zn ferrites, both with and without assuming fluctuations in composition. E. P. WOHLFARTH

538.11

8835. The critical field curve in an antiferromagnetic crystal. C. G. B. Garrett. *J. Chem. Phys.*, **19** 1154–61 (*Sept.*, 1951).

Van Vleck's theoretical model for the antiferromagnetic state is extended to describe the effect of applying magnetic fields so large that the Zeeman splitting is of the same order of magnitude as the exchange interaction. The intensity of magnetization, entropy, and Gibbs free energy are calculated. It is concluded that, when the field is applied parallel to the direction of the antiferromagnetic chains, the antiferromagnetic configuration (that in which there are two sublattices in the crystal possessing unequal magnetizations) is energetically favoured for all values of H and T at which it is mathematically permissible. The boundary of the antiferromagnetic solution is a certain critical field curve in the H, T plane, ending at the Curie temperature T_C on the T axis, and at a critical field H_C on the H axis, related to T_C by $\mu H_C/kT_C = 1$. The case of perpendicular field, and the influence of next-to-nearest neighbour interaction, are also discussed. Comparison is made between the predictions of the theory and the results of recent experiments by the writer on critical field phenomena in Co ammonium sulphate at temperatures below 1°K. This theoretical treatment of exchange antiferromagnetism is contrasted with the theory of Sauer and Temperley on dipole-dipole interaction co-operative effects, which also predicts the existence of a critical curve. The possibility of observing critical field effects in other materials at much higher or much lower temperatures is also discussed. A.

538.114 : 548.7

8836. Statistics of the simple cubic lattice. A. J. Wakefield. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 2) 419–35 (*April*, 1951).

The Ising theory of ferromagnetism (*Z. Phys.*, **31** 253 (1925)] and the theory of regular solutions both treat systems arranged on a lattice and assume that each system interacts only with its nearest neighbours. The partition functions for these two problems, for a simple cubic lattice, are examined in some detail. Power series expansions of these partition functions are obtained. Ferromagnetism, anti-ferromagnetism, spontaneous magnetism, order-disorder, phase separation and long-range order, are discussed. A comparison is made with other authors' treatments of the

partition function. [Bethe, *Proc. Roy. Soc. A*, **150**, 552 (1935); Kirkwood, *J. Chem. Phys.*, **6**, 130 (1938)].
A. R. STOKES

538.12 : 621.313.84 : 538.3

Generator for production of high magnetic fields. *See Abstr.* 8849

538.12 : 621.316.721

8837. Magnet current stabilizer. H. S. Sommers, Jr, P. R. Weiss and W. Halpern. *Rev. Sci. Instrum.*, **22**, 612–18 (*Aug.*, 1951).

The design and performance of a feedback amplifier for the precision control of the current through a 40 kW magnet is described. The system uses the difference between the *IR* drop in a standard resistor and a preset potentiometer voltage to control the current. The principal components are a high gain vibrator amplifier and a stabilized power amplifier incorporating a commercial motor-generator set. Current fluctuations are kept below one part in 10^6. A.

538.22

8838. A modification of Sucksmith's method for the measurement of susceptibilities of para- and ferromagnetic materials at temperatures between −180°C and 1 100°C. W. P. van Oort. *J. Sci. Instrum.*, **28**, 279–82 (*Sept.*, 1951).

A detailed description is given of an apparatus to measure magnetic susceptibilities of small quantities (about 10 mg) of para- and ferromagnetic substances. Special attention is paid to the construction of a low and a high temperature thermostat of such dimensions as to ensure easy handling in a pole gap not wider than 16 mm. Pre-treatment of the sample, as for instance degassing, reduction, oxidation and high temperature structural changes can be performed *in situ*. The range of susceptibilities covered is $+5\times10^{-6}$ to $+1\,000\times10^{-6}$ e.m.u. The accuracy varies between 1 and 2% depending on the magnitude of the susceptibility. A.

538.221

8839. Coercive force of ferro-nickel powders. Influence of compression and of sintering. L. Weil. *J. Phys. Radium*, **12**, 520–6 (*April*, 1951) *In French.*

Measurements of the coercive force of compacts of Fe–Ni powders containing > 50% Ni and prepared under different pressures, show that before heating the coercive force is determined by shape anisotropy of the particles as proposed by Neel. The reduction of the coercive force on partial sintering is attributed to the formation of Bloch zones where the particles have joined together. A. E. De Barr

538.221

8840. Ferromagnetic resonance absorption and a new transition in $NiOFe_2O_3$ at low temperature. T. Okamura. Letter in *Nature, Lond.*, **168**, 162 (*July* 28, 1951).

Phenomena are similar to those observed in magnetite. L. Pincherle

538.221

8841. Ferromagnetic resonance absorption in $MnOFe_2O_3$ at low temperatures. T. Okamura and Y. Torizuka. Letter in *Phys. Rev.*, **83**, 847 (*Aug.* 15, 1951).

Results of experiments at 3·22 cm and between 150°C and −190°C with varying static fields, up to 6 000 oersted, are described. In the transition region, 20°C to −150°C, the absorption curves exhibit double peaks, the resonance field values being linearly dependent on temperature, as in nickel ferrite. E. P. Wohlfarth

538.221 : 537.226.2 : 621.3.011.5 : 621.318.2

On the dielectric and magnetic properties of several ferrites at high frequencies. *See Abstr.* 8720

538.222

8842. A micromethod for the determination of paramagnetic susceptibility of substances in dilute solutions. H. Theorell and A. Ehrenberg. *Ark. Fys.*, **3**, *Paper* 16, 299–313 (1951).

A variation of the Gouy method employing a horizontal sample tube with bifilar suspension. The tube is short and kept in the same position during the measurements by moving the upper fixing points of the suspensions. The displacement of the latter is a measure of the magnetic force. Both water and organic solvents can be used depending on the material of which the sample tube is made. A single determination requires only 0·3 ml of solution and can be completed within 15 min with an error in $\Delta\kappa$ of $\pm 4\times10^{-10}$ cgs. A.

538.222

8843. Proton magnetic resonance absorption in hydrogen perchlorate monohydrate and the structure of oxonium ion. Y. Kakiuchi, H. Shono, H. Komatsu and K. Kigoshi. Letter in *J. Chem. Phys.*, **19**, 1069 (*Aug.*, 1951).

From the shape of the proton resonance absorption line of $HClO_4 . H_2O$ polycrystal it is deduced that the oxonium ion occurs. At low temperatures its orientation is fixed, above −130°C it rotates; O − H = 0·98 Å, O − H − O = 110°C. J. Jacobs

538.222

8844. Paramagnetic resonance absorption in three chlorides of copper. J. Itoh, M. Fujimoto and H. Ibamoto. Letter in *Phys. Rev.*, **83**, 852 (*Aug.* 15, 1951).

Measurements were carried out on single crystals of $CuCl_2 . 2H_2O$, $K_2CuCl_4 . 2H_2O$, $(NH_4)_2CuCl_4 . 2H_2O$ at 3 100 Mc/s at R.T. Calculated *g*-values are compared with observed values. The observed absorption curves differ in shape from a Gaussian curve, and the experimental half-widths can thus not be compared directly with Van Vleck's theoretical values.
E. P. Wohlfarth

538.222 : 541.67

8845. Magnetochemistry of the heaviest elements. IV. Plutonium trifluoride and trichloride. J. K. Dawson, C. J. Mandleberg and D. Davies. *J. Chem. Soc.* (1951) 2047–50 (*Aug.*).

For Pt III, see Abstr. 4535 (1951). The magnetic susceptibilities of PuF_3 and $PuCl_3$ have been measured over the temperature range 90–600°K. There is a minimum between 500° and 550°K in the susceptibility-temperature curve of the tervalent Pu ion, and the close resemblance of this behaviour to that

of the tervalent Sm ion is taken as good qualitative evidence for a $5f^5$ electronic configuration for the Pu ion. The application of Van Vleck's method for calculating the theoretical susceptibility yields 58 as the most probable value of the spin-doublet screening constant. A.

538.222 : 547.67

8846. Paramagnetic resonance absorption of microwaves. F. W. Lancaster and W. Gordy. *J. Chem. Phys.*, **19**, 1181–91 (*Sept.*, 1951).

Paramagnetic resonance absorption in approximately 100 salts in the powder form, containing atoms of the Fe and rare earth groups and organic as well as inorganic radicals, has been investigated. The frequencies employed range from 9 000 to 50 000 Mc/s. Exchange interaction which affects markedly the line widths and shape was found to be of wide occurrence even in ions separated by large organic radicals. The results indicate that paramagnetic resonance is a promising method of investigating the orbital properties of these organic radicals. Evidence has been found in Cu acetate for the simultaneous transition of electrons in neighbouring ions with the absorption of a single quantum. A.

538.224

8847. The diamagnetic susceptibility of some substituted ethyl malonates. C. M. French and V. C. Trew. *Trans Faraday Soc.*, **47**, 365–70 (*April*, 1951).

A modified technique has been evolved for the more precise measurement of magnetic susceptibility by the Gouy method. The diamagnetic susceptibilities of a number of substituted ethyl malonates have been measured, and a considerable variation in the magnitude of the CH_2 increment within this series has been found, although certain regularities appear to exist. The absolute value of the CH_2 increment in this series of compounds is higher than that in many simple homologous series previously investigated. A comparison of the experimental molar mass susceptibilities with those calculated by the method of Pascal indicates the presence of both ketonic and partially enolic forms in ethyl malonate and the monosubstituted esters. This magnetic evidence is supported by evidence from molar refractivity data. A.

538.24

8848. The value of the spontaneous magnetization of binary nickel alloys as a function of temperature. J. J. Went. *Physica*, **17**, 596–602 (*June*, 1951).

The I_s *v.* T curve for pure Ni is more concave towards the T-axis than that for any binary Ni alloy, with only one exception, viz. completely ordered alloys, such as slowly-cooled Ni_3Fe. For pure Ni the form of the I_s *v.* T curve can be explained by the occurrence of an order-disorder phenomenon of the magnetic moments where the latter can be placed only parallel or anti-parallel. It is suggested that all the other I_s *v.* T curves must be explained as being a result of this order-disorder phenomenon and the statistical fluctuations of the concentration of dissolved atoms. In the case of Ni_3Fe two different order-disorder phenomena (a crystallographic and a magnetic) act simultaneously. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 538.12 : 621.313.84

8849. Pulsed air core series disk generator for production of high magnetic fields. R. I. Strough and E. F. Shrader. *Rev. Sci. Instrum.*, **22**, 578–82 (*Aug.*, 1951).

The possibility of the efficient storage of large amounts of energy and its subsequent rapid conversion into useful electromagnetic energy has been studied. Efficient and economical storage of energy is possible in the form of kinetic energy of rotation. Conversion of energy stored in this manner into electromagnetic energy has been accomplished by using the rotating mass as the armature of a series wound homopolar generator. A successful prototype generator has been built and its performance compared with the theoretical operation of such a device. The prototype generator was capable of storing 29 000 joules when operating at 20 000 r.p.m. When it is operated under short circuit conditions, a current pulse of 56 000 amperes maximum is obtained in the single-turn series field coil. Liquid mercury brushes were developed especially for this generator, since very low circuit resistance is required for self-excited operation. The starting of the flow of mercury in the brush system serves to start the generator in operation. The possible further development and uses of this generator are discussed. A.

538.521 : 550.837.6

8850. Scale model experiments in electromagnetic methods of geophysical exploration. A. R. Clark and A. G. Mungal. *Canad. J. Phys.*, **29**, 285–93 (*July*, 1951).

A method of accurately measuring the phase as well as the amplitude of alternating magnetic fields of small amplitude has been devised and applied to the investigation of the response of conducting bodies placed in an electromagnetic field. The results have indicated how the position, dimensions and dip of buried conductors may be evaluated. A.

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 537.311.31

8851. On electrostatic plasma oscillations in metals. J. A. Kok. *Physica*, **17**, 543–7 (*May*, 1951).

An attempt is made to apply to metals the equations of the electrostatic plasma oscillations of the electrons and ions in electrical discharges in gases. It is pointed out that for electrons in metals the Fermi–Dirac distribution law has to be used and not the Maxwell statistics. The frequencies of the electrostatic ion oscillations have an upper limit of the same order of magnitude as the Debye maximum frequency. A.

538.566

8852. Dispersive media which do not show the Fizeau-Fresnel effect. N. Carrara. *Nuovo Cim.*, **8**, 569–76 (*Aug.*, 1951) *In Italian.*

There are dispersive media in which electromagnetic

waves propagate in such a way that the product of phase and group velocities equals the square of the velocity of light. It can be shown that for these media the partial convection is zero, that the Michelson–Morley experiment would give a negative result and that it would be impossible to determine with experiments of that kind the movement of any reference system with respect to the media. A.

538.566.2

8853. Erratum: Magneto-optics of an electron gas with guided microwaves. L. GOLDSTEIN, M. LAMPERT AND J. HENEY. Letter in *Phys. Rev.*, **83**, 1053 (*Sept.* 1, 1951). See Abstr. 7126 (1951).

538.566.2 : 621.396.11

8854. The effective speed of transmission of short radio waves. J. FUCHS. *Arch. Met., Geophys. Bioklimatol., Ser. A*, **3** (*No.* 1–2) 139–52 (1950) *In German.*

Various observations of speed of radio-waves and light waves are quoted and discussed. From the effective height of the reflecting layer and the angle of incidence, the ratios of the distance between transmitter and receiver to the actual distance travelled, × velocity of light (taken as 299 794 km/sec), the effective speeds are calculated. METEOROLOGICAL ABSTRACTS

538.566.2 : 621.396.11

8855. Long distance scattering of radio signals. S. S. BANERJEE AND V. D. RAJAN. *J. Sci. Industr. Res.*, **10B**, 161–4 (*July*, 1951).

Observations made at Banaras of 31 m signals received from Delhi during night hours are reported. These are presumably scattered from ground objects beyond the transmitter, being twice reflected at the ionosphere at oblique incidence. The intensity is much lower than when transmitter and receiver are close together.

538.566.2 : 621.396.11

8856. Intensity of scattered radio signals from distant transmitters. S. S. BANERJEE, V. D. RAJAN AND R. R. MEHROTRA. Letter in *J. Sci. Industr. Res.*, **10B**, 172–3 (*July*, 1951).

See Abstr. 8855 (1951). An enhancement of scattered signal as night advances is reported. This is explained as due to an increase of the scattering coefficient at the ground (assumed to be made up of surfaces oriented at random) as the angle between the incident and back-scattered rays decreases; i.e. as the obliquity of the ionosphere reflection increases.

538.566.2 : 621.396.11

8857. A study of tropospheric scattering of radio waves. A. W. STRAITON, D. F. METCALF AND C. W. TOLBERT. *Proc. Inst. Radio Engrs*, **39**, 643–8 (*June*, 1951).

The theory of tropospheric scattering of radio waves recently advanced by Booker and Gordon [*Proc. Inst. Radio Engrs*, **38**, 401–12 (*April*, 1950)] makes the prediction that r.f. energy may arrive from a ground-based v.h.f. transmitter at angles well above the horizon, and also that signals received as a result of the scattering process will attenuate less rapidly with distance if the polarization of the source is horizontal than if it is vertical. Experimental observations made at 3 m and 3 cm have verified these deductions. A.

538.566.2 : 621.396.11

8858. The diffraction of electromagnetic waves around the earth in an optically inhomogeneous medium. R. SCHACHENMEIER. *Arch. elekt. Übertragung*, **5**, 267–72 (*June*, 1951) *In German.*

A mathematical paper in which the problem is considered in terms of the principle of geometrical optics and of non-euclidean geometry. The limitations in the applicability of the analysis are discussed. See Abstr. 3666 (1951). W. J. G. BEYNON (R)

538.566.2 : 621.396.671 : 621.396.11

8859. The ground-wave of a transmitter. H. OTT. *Z. angew. Phys.*, **3** (*No.* 3–4) 123–34 (1951) *In German.*

It is shown that the ground-wave has as its source the production of a "head-wave" within the earth. The evolution of heat within the earth is not the reason for the forward tilt of the ground-wave but is merely an accompanying phenomenon. The whole of the sky-wave is not involved in feeding this internal radiation, but only a thin boundary layer which is in fact the ground-wave. This is shown by considering the propagation over a pure dielectric earth. Here the solution is quite simple as it involves an already tabulated function, the Fresnel integral for real argument. A graphical method is used which is later extended to the case of an earth with complex refractive index. The results are presented in the form of a number of curves. S. C. DUNN (R)

538.566.3 : 621.396.11

8860. Vertical propagation of electromagnetic waves in the ionosphere. M. N. SAHA, B. K. BANERJEA AND U. C. GUHA. *Proc. Nat. Inst. Sci. India*, **17**, 205–26 (*May–June*, 1951).

A connected discussion of the equations for the vertical propagation of e.m. waves in the ionosphere is given in standardized notation. It is shown that the electric field vector components E_x and E_y are coupled by polarization terms, ρ_1, ρ_2 which are functions of G.M. latitude and height; and the propagation vectors, V and W, equal respectively to $(E_x + i\rho E_y)/\sqrt{(1+\rho^2)}$, for two values of ρ, are governed by two refractive indices q_0, q_e and a coupling term ϕ; V and W may be identified with *o*- and *e*-waves respectively. The five quantities needed to define wave propagation completely are ρ_1, ρ_2, ϕ, q_0 and q_e; a detailed discussion is given of the first three, and discussions are omitted about q_0 and q_e which are identical with those given by Appleton and have been discussed in detail by Booker (1935) and others. It is shown that the coupling term ϕ can be neglected everywhere for *F*-layer propagation except very near the G.M. poles, while the *E*-layer propagation is more difficult to handle. A.

538.566.3 : 621.396.11

8861. The reflection of very low frequency radio waves at the surface of a sharply bounded ionosphere with superimposed magnetic field. K. G. BUDDEN. *Phil. Mag.*, **42**, 833–50 (*Aug.*, 1951).

Discusses the theory of the reflection of v.l.f. e.m. waves at the boundary of an ionized medium. The medium is assumed to be sharply bounded and homogeneous, and to have a steady magnetic field superimposed. The quasi-longitudinal approximation

to the magneto-ionic theory is used (Booker, 1935), and the reflection coefficients are then independent of the horizontal direction of the transmission path. The results of the theory are compared with the experimental observations of the propagation of very low frequency radio waves (Bracewell *et al.*, 1951). It is concluded that the theory will account for the general form of some of the experimental results for frequencies of 16 kc/s and above. It is likely to be most useful for extending the theory of v.l.f. propagation (10 kc/s and lower) as used in the study of the propagation of radio-atmospherics. A.

MAGNETIC EFFECTS 538.6

538.61

8862. The magneto-optic constants of sodium bromide. S. RAMASESHAN. Letter in *Curr. Sci.*, **20**, 150 (*June*, 1951).

538.614

8863. Faraday effect of strong electrolytes in aqueous solutions. IX. The temperature dependence of the molecular rotation constants. I. A. OKAZAKI. *J. Phys. Soc. Japan*, **6**, 138–40 (*May–June*, 1951).

The molecular rotations $M[\omega]$ and the molecular rotation constants $M[D]$ $\{[D] = n[\omega]\lambda^2/(n^2+2)^2$ where n = refractive index, λ = wavelength in cm of the light used$\}$ of NaCl, KCl, KBr in aqueous solution at 35° using Na D-lines are constant over the fairly wide concentration ranges examined.

W. R. ANGUS

538.614 : 535.55

8864. Faraday effect and birefringence. S. RAMASESHAN AND V. CHANDRASEKHARAN. Letter in *Curr. Sci.*, **20**, 150–1 (*June*, 1951).

The Faraday effect enables the photo-elastic constants of isotropic solids to be determined from the rotation of the plane of polarization in a strained and unstrained state. R. W. FISH

538.632

8865. On the theory of the Hall effect. H. KOPPE AND J. M. BRYAN. *Canad. J. Phys.*, **29**, 274–84 (*July*, 1951).

A phenomenological theory of the Hall effect is applied to: (1) the effect of an inhomogeneous magnetic field on the Hall effect in thin layers; (2) the magnetic increase of resistivity under the same conditions; (3) the Hall effect in a homogeneous magnetic field in inhomogenous layers. The first paragraphs give a simple kinetic theory. A.

538.639

8866. Magnetoresistance of ferromagnetic metals and alloys at low temperatures. J. SMIT. *Physica*, **17**, 612–27 (*June*, 1951).

The magneto-resistance of pure Ni and Fe, of Ni–Fe, Ni–Co and Ni–Cu alloys, and of Heusler's alloy has been measured at room temperature and at temperatures of liquid N and liquid H. The behaviour of the pure metals is essentially different from that of the alloys. At low temperatures a maximum in the magneto-resistance is observed for alloys having about one Bohr magneton per atom. The positive difference between the longitudinal and the transversal resistance can be explained by means of the spin-orbit interaction. At low temperatures the pure metals show an increase in resistance with increasing field just as the non-ferromagnetic metals. From this the value of the internal field, acting on the conduction electrons, could be determined, and was found to be approximately equal to the induction B. A.

538.652

8867. Magnetostriction in a rotating field. T. DELOURMEL AND A. HERPIN. *C.R. Acad. Sci., Paris*, **233**, 239–41 (*July* 16, 1951) *In French.*

A brief theoretical discussion. Application to the Wiedemann effect. E. P. WOHLFARTH

538.653.11

8868. Variation of the saturation magnetization of iron under elastic multilateral compression stress. F. GALPERIN. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 451–2 (1951) *In Russian.*

The author investigated the effect of high pressure on the saturation magnetization of pure metals (Fe, Ni) and alloys with a view to checking his previous formulae correlating atomic magnetic moment (saturation magnetization) with the interatomic distances in the lattice, lattice type, coordination number, etc. [Abstr. 6022 (1950)]. These formulae express that the magnetic moment depends linearly on the interatomic distances and thus must be reduced under multilateral compression, and increase under tensile stress. These propositions were already qualitatively confirmed by experiments of the author *et al.*, although not quantitatively. An experiment with iron under multilateral compression in saturation fields (1 300–4 000 oerst.) yielded satisfactory quantitative agreement with the author's formula. It may also be concluded that the decrease of the magnetic moment of the atom (i.e. of the average number of unoccupied places in the 3*d*-shell of the atom) is apparently due to the fact that under multilateral pressure some of the outer 4*s*-electrons pass into the 3*d*-shell. B. F. KRAUS

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

8869. Relation of antiferromagnetic structure to the binding energies of some b.c.c. transition metals. Y.-C. HSU. *Phys. Rev.*, **83**, 975–9 (*Sept.* 1, 1951).

Zener's theory of antiferromagnetic structure for V, Cr, Nb, Mo, Ta and W is discussed from the point of view of binding energy. According to such a picture the large binding energies must come from Coulomb interaction between cores. The importance of the outer d electrons in achieving large Coulomb

attraction is pointed out. A mathematical scheme for treating binding energy in the case of extensive overlap of cores is discussed. By dismissing the contribution of a Wigner–Seitz type calculation, the remaining contributions to the binding energy of W are calculated at the observed lattice constant. Results obtained demonstrate the importance of the Coulomb attractive energy in an antiferromagnetic structure. A.

539.11 : 531.396

8870. Discussion on the extent of the many particle problem in molecular physics. Ya. P. Terletskiĭ. *J. Exp. Theor. Phys., USSR*, **20**, 854–9 (*Sept.*, 1950) *In Russian.*

A criticism of A. A. Vlasov [Abstr. 461 (1949)] who attempted to explain the many-particle problem in the spirit of Mach's idealistic theory, by proposing that the equations of the self-co-ordinated field apply to any molecular system. This denial of the materialistic interpretation of heat theory is deplored. J. JACOBS

539.11 : 534.2

8871. Wave propagation in one-dimensional structures. J. M. Luttinger. *Philips Res. Rep.*, **6**, 303–10 (*Aug.*, 1951).

A conjecture of Saxon and Hutner on the forbidden energy levels of any substitutional alloy of a certain one-dimensional crystal model is proved. Analogous results are derived for wave transmission down a line loaded with two-terminal networks. A.

539.11 : 621.315.5

8872. The electron theory of solids. J. C. Slater. *Amer. J. Phys.*, **19**, 368–74 (*Sept.*, 1951).

A brief review of the way in which the original ideas of Lorentz and Drude on the electron theory of solids have been expanded to cover the quantum theory of the electron gas, the energy band theory, with applications to the distinction between conductors, semiconductors and insulators, and to treat not only electrical conductivity, but mechanical, thermal, magnetic properties of solids and a wide range of phenomena. A.

MOLECULAR STRUCTURE 539.13

539.132

8873. Approximate wave-functions satisfying the virial theorem. T. L. Cottrell and S. Paterson. *Trans Faraday Soc.*, **47**, 233–5 (*March*. 1951).

It is shown that approximate wave-functions for diatomic molecules of the type in which all distances between particles are expressed as a ratio of the distance concerned to the internuclear distance, and which contain parameters λ_k defined by $\partial E/\partial\lambda_k = 0$, give values of the kinetic and potential energy which satisfy the virial theorem. A.

539.132

8874. The intensity of the A_{1g}–E_{1u} transition in benzene. C. W. L. Bevan and D. P. Craig. *Trans Faraday Soc.*, **47**, 564–9 (*June*, 1951).

A non-empirical intensity calculation is reported for the allowed A_{1g}–E_{1u} transition in benzene. Energy-minimized combinations of molecular-orbital configurations are used to describe the combining states. The calculated value is $f = 0{\cdot}81$, to be compared with the experimental $0{\cdot}69$. Single configuration wave functions lead to the calculated value $f = 2{\cdot}59$ and the reduction of this to $0{\cdot}81$ is a measure of the improvement in the wave functions when configurations are allowed to interact. The complete energy matrices, including all configurations, have been worked out in terms of two-centre integrals for the singlet states. An extension to earlier calculations removes uncertainty about the effect of hitherto neglected higher configurations. The new energy levels are reported. A.

539.132

8875. Quantum calculation of the diamagnetic anisotropy of organic molecules. I. The method. M. Mayot, G. Berthier and B. Pullman. *J. Phys. Radium*, **12**, 652–8 (*June*, 1951) *In French.*

In molecular orbitals magnetic properties follow from secular equations corresponding to a determinant with complex coeffs. By building up from simpler molecules this determinant is avoided and the secular equations obtained directly; in a number of aromatic hydrocarbons these are stated in Chebishev polynomials. J. JACOBS

539.132

8876. Theoretical determination of electron density in organic molecules. O. Klement. Letter in *Nature, Lond.*, **168**, 162 (*July* 28, 1951).

Calculations based on the Heitler–Rumer method of obtaining zeroth-order wave functions for naphthalene lead to the same qualitative relationship of electron densities as X-ray analysis. J. JACOBS

539.132

8877. The oscillator strength of H_2^+, $1s\sigma - 2p\sigma$. D. R. Bates. *J. Chem. Phys.*, **19**, 1122–4 (*Sept.*, 1951).

The $1s\sigma - 2p\sigma$ transition of H_2^+ is investigated using exact two centre wave functions and using approximate wave functions based on a linear combination of atomic orbitals (with both the dipole length and the dipole velocity formulae). It is found that at the equilibrium internuclear distance, $2{\cdot}00\ a_0$, the true oscillator strength of the transition is $0{\cdot}319$; with the dipole length formula, the LCAO approximation yields a value some $1{\cdot}4\times$ greater, and with the dipole velocity formula it yields a value some $0{\cdot}54\times$ smaller. Results are given for internuclear distances between 0 and $9\ a_0$. A.

539.132

8878. Asymptotic expansion of the partition function of the asymmetric top. K. F. Stripp and J. G. Kirkwood. *J. Chem. Phys.*, **19**, 1131–3 (*Sept.*, 1951).

Methods developed by Wigner and Kirkwood for the determination of the partition functions of dynamical systems without explicit knowledge of the energy eigenvalues are used to calculate the first two terms of the asymptotic expansion of the partition function of the asymmetric top in powers of Planck's constant. The result is compared with Viney's expansion for the symmetric top and with Gordon's approximate expansion for the asymmetric top. A.

539.132

8879. Hydrogen molecule energy calculation by correlated molecular orbitals. A. A. Frost and J. Braunstein. *J. Chem. Phys.*, **19**, 1133–8 (*Sept.*, 1951).

The electronic energy of the hydrogen molecule was calculated using the correlated molecular orbital wave function $\psi = (a_1 + b_1)(a_2 + b_2)(1 + pr_{12})$, where a_1, b_1, a_2 and b_2 are $1s$ atomic wave functions of electrons 1 and 2 about nuclei a and b, and r_{12} is the interelectronic distance. The p of the above formula together with z, the effective nuclear charge, used in the explicit definition of the atomic orbitals, are two parameters which are varied in minimizing the energy according to the variation method. The energy minimum was found to be 4·11 eV below the value for complete separation of the nuclei. The minimum occurred at an internuclear distance of 0·71 Å, and the parameters have the values $z = 1{\cdot}285$ and $p = 0{\cdot}28$ in atomic units. The energy is far better than Coulson's best molecular orbital calculation and better than any other two-parameter calculation except for that of Gurnee and Magee. A.

539.132

8880. The parallel vibrations of linear triatomic molecules. W. J. O. Thomas. *J. Chem. Phys.*, **19**, 1162–6 (*Sept.*, 1951).

The possible solutions of the valence force potential constants occurring in the potential function for the stretching modes of some triatomic molecules are found; these are found as functions of a parameter p related to the co-ordinates describing the parallel modes of vibration. The form of the normal modes and the potential energy distribution corresponding to a particular set of constants for each molecule is obtained. A.

539.132 : 535.338.4

Predissociation and dissociation of the N_2 molecule. *See Abstr.* 8624

539.132 : 535.338.4

Spectrum and structure of the boron monosulphide (BS) molecule. *See Abstr.* 8625

539.132 : 535.343.4–15

Analysis of the infrared spectrum of ClF. *See Abstr.* 8645

539.132 : 536.7

8881. Force constants and calculated thermodynamic properties for SiF_4. F. L. Voelz, A. G. Meister and F. F. Cleveland. *J. Chem. Phys.*, **19**, 1084–5 (*Sept.*, 1951).

Using observed fundamental frequencies and the Wilson *FG* matrix method, sets of force constants for SiF_4 have been determined using the most general second degree potential energy function. While no unique set of force constants can be given, limits are set for the force constants. Also the calculations indicate that if the Si–F bond interaction constant is ignored, too high a value for the Si–F bond stretching force constant results. Finally, the heat content, free energy, entropy and heat capacity for the ideal gaseous state at 1 atmos. pressure were calculated for 11 temperatures ranging from 100–1 000°K, using a rigid rotator, harmonic oscillator approximation. A.

539.132 : 537.561

8882. Lack of resonance energy in gaseous carbonium ions. J. L. Franklin and H. E. Lumpkin. Letter in *J. Chem. Phys.*, **19**, 1073–4 (*Aug.*, 1951).

The appearance potential of allyl, benzyl and other ions shows that no resonance energy occurs; hence it is concluded that no resonance energy results from interaction of a π-electron and a vacant orbital.

J. JACOBS

539.133

8883. The variation of dipole moment with state for *n*-propyl- and *n*-butyl-amines. With notes on the apparent moments in solution of certain other amines. G. A. Barclay, R. J. W. Le Fèvre and B. M. Smythe. *Trans Faraday Soc.*, **47**, 357–65 (*April*, 1951).

The two compounds mentioned resemble other amines previously studied in showing a "positive" solvent action by benzene. Experimental observations are briefly discussed in terms of the Barclay-Le Fèvre empirical relation. The paper includes a number of redeterminations of the apparent moments (by the refractivity method) of some aromatic amines and their derivatives. A.

539.133

8884. The computation of electric dipole moments. E. A. Guggenheim. *Trans Faraday Soc.*, **47**, 573–6 (*June*, 1951).

The method of computing electric moments advocated in a previous paper [Abstr. 1122 (1940)] is modified, further simplified and illustrated by an example from recent experimental work. A.

539.133

8885. Determination of the two-dipole moment components in nitrosyl fluoride. D. W. Magnuson. Letter in *J. Chem. Phys.*, **19**, 1071 (*Aug.*, 1951).

A reasonable assignment is $\mu(NF) = 1{\cdot}75$, $\mu(NO) = -0{\cdot}17$ D. This uses $N - F = 1{\cdot}52$ Å, $N - O = 1{\cdot}13$ Å, $\angle ONF = 110°$. J. JACOBS

539.133 : 535.343.4–14

Molecular constants of $Cs^{133}Cl^{35}$. *See Abstr.* 8642

ATOMIC STRUCTURE . NUCLEUS . ISOTOPES 539.15

539.152.1

8886. On the statistical distribution of the widths and spacings of nuclear resonance levels. E. P. Wigner. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 4) 790–8 (1951).

If the average spacing of the resonance levels is very small as compared with the range of energy in which the spacing or width of the levels changes appreciably on the average, one can speak of a statistical distribution of the level spacings and widths. The question then comes up naturally, whether the "distribution law" for width and spacing is different for protons, neutrons, etc., i.e. whether it depends on the long-range interaction of the scattered particle. It is pointed out that while the average width must depend on the long-range interaction (on account of the penetration factor) the distribution of the widths, if these are measured in terms of their average, can

be expected to be independent therefrom. In the case of the level spacings, not only the distribution about the average, but the average itself is also independent of the long-range interaction. It is pointed out, incidentally, that the logarithmic derivative of the wave function at the surface of the nucleus will have, on the whole, a positive value between resonances because of the greater effect of the high-energy resonances than that of the bound states. A.

539.152.1

8887. Shells in heavy nuclei and binding energies of nucleons. V. A. KRAVTSOV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 1) 43–6 (1951) *In Russian.*

The mass differences of heavy nuclei differing by one neutron or proton, and by two neutrons or protons are plotted against N and Z. The latter data appear more regular. Discontinuities at $N = 126$, $Z = 82$ are discussed on the shell model.

E. P. GEORGE

539.152.1

8888. Shells in light nuclei and binding energies of nucleons. V. A. KRAVTSOV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 2) 239–42 (1951) *In Russian.*

The investigation of the previous abstract is repeated for light nuclei. E. P. GEORGE

539.152.1

8889. Structural laws of atomic nuclei. M. M. VENKOV. *J. Exp. Theor. Phys., USSR*, **21**, 51–8 (*Jan.*, 1951) *In Russian.*

On the basis of an analysis of the binding energies of nuclei with mass numbers from 9 to 32, a two tiered, chain-like structure is advanced for the nucleus, e.g. for Mg^{24} the following structure is postulated, where n is the neutron, p the proton and – represents a nucleonic bond.

1st tier n–p–n–p–n–p–n–p–n 2nd tier p–n–p

p–n–p–n–p–n–p–n n–p–n–p

For Mg^{25} a neutron is added to the 2nd tier to give n–p–n–p with the formation of one more bond.

n–p–n–p

For Mg^{26} a proton enters the 2nd tier to give n–p–n–p,

p–n–p–n–p

two more bonds being formed this time. The binding energies of these three isotopes are respectively 198, 205, 217 MeV with differences of 7 and 12 which are roughly equivalent to the formation of one and two nucleonic bonds respectively. A more detailed survey indicates that one nucleonic bond is equivalent to 6·4 MeV. Neutrons and protons in the middle of the chains are connected to each other by three nucleonic bonds while terminal neutrons and protons have only two nucleonic bonds. A table is included of the nuclear structures of various isomers between B^{11} and Si^{30}, on the basis of the above hypothesis.

W. HUGHES

539.152.1

8890. On the correlation between the discontinuities in the mass valley and nuclear shells. Application to the study of the systematics of α-emission. A. BRONIEWSKI. *Canad. J. Phys.*, **29**, 193–202 (*March*, 1951) *In French.*

The variations in position of the stability limits in an N–Z diagram are correlated with the magic numbers. The evidence for a sub-shell at $N = 148$ is discussed. W. J. SWIATECKI

539.152.1

8891. Binding energy surfaces in the region of the magic numbers $Z = 82$ and $N = 126$. A. H. WAPSTRA. *Physica*, **17**, 628–36 (*June*, 1951).

The influence of the magic numbers $Z = 82$ and $N = 126$ on the binding energies is shown in some curves; for some purposes it may be represented by a bell-shaped addition to the Bethe–Weiszäcker formula. A table is given of binding energies of isotopes with masses between 203 and 218. A.

539.152.1

8892. On the binding energies of light nuclei. J. SANADA AND Y. YOSHIZAWA. Letter in *Phys. Rev.*, **83**, 663 (*Aug.* 1, 1951).

The binding energies of the last nucleon and the last neutron-proton pair are studied, where $T = N - Z = 0$ or 1. The results are given as graphs. No evidence of shell closing at 20 nucleons was found.

F. R. HOLT

539.152.1

8893. Erratum: Low states of Li^7 in intermediate coupling. H. H. HUMMEL AND D. R. INGLIS. Letter in *Phys. Rev.*, **83**, 1078 (*Sept.* 1, 1951).

See Abstr. 5658 (1951).

539.152.1 : 539.163

8894. Classification of nuclear isomers. M. GOLDHABER AND A. W. SUNYAR. *Phys. Rev.*, **83**, 906–18 (*Sept.* 1, 1951).

The lifetime-energy relations of Axel and Dancoff and the K/L ratios calculated by Hebb and Nelson are shown to yield spin differences ΔI which are one unit too high for long-lived electric transitions ($\Delta I \geqslant 3$). These transitions are also slower than expected from Weisskopf's one-particle model and have approximately the same lifetime as magnetic transitions of equal ΔI. The lifetimes of magnetic transitions agree approximately with Weisskopf's formula. If the statistical weight of the initial state is introduced into the lifetime formula, the "scatter" of the square of the matrix elements is greatly reduced for these transitions. Most long-lived isomers show $M4$ transitions, in agreement with shell theory. Some isomeric transitions which were previously assumed to show no parity change are now interpreted as $E3$. Their occurrence in the $1g_{9/2}$ shell may be explained by assuming that for the configurations $(g_{9/2})^{3,5 \text{ or } 7}$, $7/2+$ and $g_{9/2}$ states are comparable in energy. The $7/2+$ state is lower in more than half of the cases. Empirical curves of K/L ratios plotted against Z^2/E are given. They are consistently lower than the existing theoretical curves based on non-relativistic calculations of internal conversion coefficients. Spins of metastable and ground states are assigned for a number of nuclei. For even-even nuclei the following rule is found: the first excited state usually has spin 2 and even parity. The only mixed transitions found

are $M1 + M2$. Sufficiently many $E3$ transitions are established to permit the conclusion that electric transitions are slower for odd-neutron nuclei than for odd-proton nuclei. This gives strong support to a one-particle model. Among electric transitions only some $E2$ transitions are faster than expected on the one-particle model. This is interpreted as a co-operative phenomenon, related to the existence of large quadrupole moments. A.

539.152.2

8895. On the question of magnetic moments of nucleons. I. G. HEBER. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 151–68 (1951) *In German.*

With a view to the evaluation of the nucleon magnetic moments the equations of the nucleon field coupled scalarly to a real, scalar meson field with field quantization in the Heisenberg representation were integrated to second order in the coupling constant, using the method of G. Källén [Abstr. 6246 (1950)]. The expectation values of the electric current operator were evaluated to second order for "one nucleon, no mesons" and hence the extra magnetic moments were deduced. The calculation is Lorentz-invariant, charge symmetric; the results are invariant with respect to the Pauli–Villars "formal regularization" and agree with those of K. M. Case [Abstr. 5949 (1949)]. W. J. SWIATECKI

539.152.2

8896. On the question of the magnetic moments of nucleons. II. G. HEBER. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 169–80 (1951) *In German.*

The methods developed in I are applied to the case of a complex, scalar or a real (or complex) pseudoscalar meson with scalar or pseudoscalar coupling. The results again agree with those of K. M. Case [Abstr. 5949 (1949)]. W. J. SWIATECKI

539.152.2

8897. Beats of beats. G. J. BÉNÉ, P. M. DENIS AND R. C. EXTERMANN. *Physica*, **17**, 308–9 (*March–April*, 1951) *In French.*

An experiment is described in which a nuclear resonance signal appears to be due to the superposition of two signals, each with a large number of beats of about the same damping but with slightly different intervals between the maxima.

L. PINCHERLE

539.152.2

8898. Nuclear moments and the structure of the nucleus. J. C. PECKER. *J. Phys. Radium*, **12**, 682–93 (*June*, 1951) *In French.*

A review of experimental methods for the determination of nuclear moments and of theoretical results on nuclear shells. L. PINCHERLE

539.152.2

8899. Angular correlations between proton and γ ray and the spins of the first excited levels of Li^7, B^{11} and O^{17}. J. THIRION. *C.R. Acad. Sci., Paris*, **232**, 2418–20 (*June* 25, 1951) *In French.*

No correlation was found between the (d, p) proton and the subsequent γ from the excited intermediate state, thus indicating spin $\frac{1}{2}$ in all 3 cases.

W. J. SWIATECKI

539.152.2

8900. Magnetic moments of even-odd nuclei. F. BLOCH. Letter in *Phys. Rev.*, **83**, 839 (*Aug.* 15, 1951).

An explanation of the deviations of the observed magnetic moments from the "Schmidt lines" is sought in terms of a "quenching" of the intrinsic moment of the odd nucleon due to its interaction with the core. The deviations show correlations with shell structure. W. J. SWIATECKI

539.152.2 : 537.133

8901. Measurement of the magnetic moment of the proton in Bohr magnetons. J. H. GARDNER. *Phys. Rev.*, **83**, 996–1005 (*Sept.* 1, 1951).

An experimental determination of the ratio of the precession frequency of the proton, $\omega_p = \mu_p H_0$, to the cyclotron frequency, $\omega_e = eH_0/mc$ of a free electron in the same magnetic field has been carried out. The result, ω_p/ω_e, is the magnitude of the proton magnetic moment, μ_p, in Bohr magnetons, since $\gamma_p = 2\mu_p/\hbar$. Possible sources of systematic error were carefully investigated and in view of the results of this investigation and the high internal consistency of the data it is felt that the true ratio, uncorrected for diamagnetism, lies within the range $\omega_e/\omega_p = 657{\cdot}475 \pm 0{\cdot}008$. If the diamagnetic correction to the field at the proton for the hydrogen molecule is applied here the proton moment in Bohr magnetons becomes $\mu_p = (1{\cdot}52101 \pm 0{\cdot}00002) \times 10^{-3}(e\hbar/2mc)$.

A.

539.153

8902. Excitation of atoms by electron collision. I. H. HORIE. *J. Phys. Soc. Japan*, **6**, 179–84 (*May–June*, 1951).

Racah's method [*Phys. Rev.*, **62**, 438 (1942); **63**, 367 (1943)] is applied to the excitation of atoms in l^n and $l^n l'$ configurations resulting in general formulae for the transition probabilities. For the d^n configurations more explicit formulae are given.

W. J. SWIATECKI

539.153

8903. Wave function of ionized lithium. P. J. LUKE, R. E. MEYEROTT AND W. W. CLENDENIN. Letter in *Phys. Rev.*, **83**, 847 (*Aug.* 15, 1951).

A wave function was calculated for the $1s2s\,^3S$-state expressed as a series of Legendre polynomials. This function, used in the Rayleigh–Ritz integral, gave the correct experimental energy. It gives a hyperfine splitting coupling factor $1 + \varepsilon = 1{\cdot}06190 \pm 0{\cdot}00003$.

L. PINCHERLE

539.153

8904. Three-quantum decay of positronium. M. DEUTSCH. Letter in *Phys Rev.*, **83**, 866 (*Aug.* 15, 1951).

It is shown that in "Freon" gas almost all annihilation processes with delays $> 8 \times 10^{-8}$ sec are due to the free three-quantum decay of orthopositronium. Extrapolation to zero pressure of the straight line relating decay rate and gas pressure gives a three-quantum decay-rate of $6{\cdot}8 \times 10^6$ sec^{-1}. See also Abstr. 5380 (1951). J. H. FREMLIN

539.153 : 537.56

Average excitation potentials of air and aluminium. *See Abstr.* 8805

539.153 : 537.561

8905. Empirical relations involving ionization potentials. J. P. TEEGAN AND A. D. WALSH. Letter in *J. Chem. Phys.*, **19**, 1070 (*Aug.*, 1951).

The plots of ionization potentials of some molecules and atoms against the ionization potentials of the isoelectronic inert gases are all straight lines. Their slopes are $> 45°$ if a proton was added, $< 45°$ if extracted, from the Ne nucleus. J. JACOBS

539.153.4

8906. "Compensated" elastic-ring balance. A. GIANSOLDATI AND E. KRONQUIST. *Ric. Sci.*, **21**, 1195–9 (*July*, 1951) *In Italian.*

A new instrument for measuring magnetic atomic moment at low temperatures. By an adequate electrodynamic system of compensation it presents the same advantages as the zero instruments. The simple method of calibration of the instrument is described and some data given of a prototype made by the authors at the Stockholm Polytechnic Physics Institute. A.

539.154.3

8907. Atomic magnetic moments of Fe, Co, Ni. N. S. AKULOV AND T. I. KAKUSHADZE. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 4) 593–6 (1951) *In Russian.*

539.155.4

8908. The mass of Cl^{39}. D. H. WILKINSON AND J. H. CARVER. Letter in *Phys. Rev.*, **83**, 466 (*July* 15, 1951).

Measurements on A^{40} [Abstr. 8975 (1951)] give the mass of Cl^{39} as $38{\cdot}97871 \pm 10$. F. R. HOLT

539.155.4

8909. Some new values of atomic masses, principally in the region of 82 neutrons. H. E. DUCKWORTH, C. L. KEGLEY, J. M. OLSON AND G. S. STANFORD. *Phys. Rev.*, **83**, 1114–17 (*Sept.*, 1951).

Some new mass comparisons are described which lead to atomic mass values for 29 stable nuclides. There is shown to be a definite mass effect associated with the closing of the 82 neutron shell and probably also with the closing of the 58 proton shell. There is evidence that the minimum of the packing fraction curve occurs at $_{28}Ni^{62}$. Recent microwave data are used to obtain the masses of Ge^{74} and Ge^{76} from the mass-spectrographically determined masses of Ge^{70} and Ge^{72}. A.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16

8910. Some new types of radioactivity. R. DAUDEL. *Bol. Radioactividad*, **22**, 121–38 (1949) *In French.*

Some very qualitative remarks on the creation of an orbital electron, double beta emission, double internal conversion and other processes where atomic electrons play a role. W. J. SWIATECKI

539.16.08

8911. Absorption corrections for radium standardization. G. M. KEYSER. *Canad. J. Phys.*, **29**, 301–9 (*July*, 1951).

The corrections have been redetermined. The measuring equipment and technique have been investigated to find the conditions necessary for minimum error. A Pb-filtered, Al-walled chamber was found to have the best characteristics. The electronic absorption coefficients measured with this chamber fit an empirical formula depending only on the atomic number. This gives a value for the absorption coefficient of Ra salts which was compared with a direct experimental value. A.

539.16.08 : 537.542

An automatic plate counter. *See Abstr.* 8801

539.16.08 : 616–073.75 : 537.542

Scintillation detector for the localization of radioactive concentrations *in vivo*. *See Abstr.* 8800

539.162

8912. Comments on nuclear decay in an electromagnetic field. K. TER-MARTIROSYAN. *J. Exp. Theor. Phys., USSR*, **20**, 937–40 (*Oct.*, 1950) *In Russian.*

The reaction cross-section of nuclear decay is investigated under the influence of a γ-quantum, of fast electrons, and in the electric field of a fast passing heavy charged particle. The case of Be^9 decay under collision with a heavy nucleus is discussed. J. JACOBS

539.162

8913. The effect of scattering on angular correlation measurements. S. FRANKEL. Letter in *Phys. Rev.*, **83**, 673 (*Aug.* 1, 1951).

A method is given for correcting measurements of angular correlations, involving electrons, for multiple scattering in the source and for the finite solid angle of the detectors. B. ROSE

539.163

8914. The nuclide P^{33} and the P^{32} spectrum. R. K. SHELINE, R. B. HOLTZMAN AND C.-Y. FAN. *Phys. Rev.*, **83**, 919–23 (*Sept.* 1, 1951).

P^{33} has been produced by the bombardment of S, Na_2S and LiCl with the 48-MeV gamma-ray spectrum of the University of Chicago betatron. The reactions involved are $S^{34}(\gamma, p)P^{33}$, $Cl^{35}(\gamma, 2p)P^{33}$ and $Cl^{37}(\gamma, \alpha)P^{33}$. The P^{33} activity has a 25 ± 2 day half-life with a $0{\cdot}27 \pm 0{\cdot}02$-MeV negative beta-ray. There is less than one (0·5-MeV) gamma for every fifteen betas. The activity was observed in the presence of P^{32}, and its ratio to the P^{32} activity did not change with chemical purification. Beta-ray spectra of the weak component observed in Oak Ridge carrier-free P^{32} indicate that this weak activity is P^{33} produced by the reaction $S^{33}(n, p)P^{33}$. The cross-section for pile neutrons for this reaction is approximately 0·029 barn. The Fermi plot of the beta-ray spectrum is straight with a log *ft* value of 5·2. A decay scheme for P^{33} is proposed. A.

539.163 : 539.185

Neutron decay: the problem and the experiments. *See Abstr.* 9009

539.163.1

8915. Can radioactive time constants be modified by external influences? R. DAUDEL. *Bol. Radiactividad*, **22**, 109–20 (1949) *In Spanish.*

A review of the interactions between nucleus and orbital electrons. L. PINCHERLE

539.163.1

8916. Lower limit for the lifetime of the 0·8 MeV excited level of Mo^{96}. F. R. METZGER. Letter in *Phys. Rev.*, **83**, 842 (*Aug.* 15, 1951).

A half-life $\geqslant 0{\cdot}5\times10^{-13}$ sec is inferred from failure to detect resonant nuclear scattering from Mo^{96}.

J. J. WILKINS

539.163.1

8917. A search for short period activities from U^{235} fission products. J. E. BROLLEY, JR., D. H. COOPER, W. S. HALL, M. S. LIVINGSTON AND L. K. SCHLACKS. *Phys. Rev.*, **83**, 990–3 (*Sept.* 1, 1951).

A search for gamma-ray activities with period 1–100 msec from thermal neutron fission of U^{235} gave negative results. $0{\cdot}43 \pm 0{\cdot}03$ sec was the shortest observed. The period of B^{12} was found to be 27 ± 3 msec. The cyclotron beam was pulsed to supply 1–10 msec neutron bursts. Coincidence scintillation detectors were employed. A.

539.163.2

8918. On the *K*-capture/positron branching ratio for Cu^{61}. C. S. COOK. Letter in *Phys. Rev.*, **83**, 462 (*July* 15, 1951).

A value of 0·47 independent of instrumental correction factors is derived from results of J. H. Reynolds [Abstr. 582 (1951)] and Bradt *et al.* [Abstr. 827 (1946)]. F. R. HOLT

539.163.2

8919. Two-step isomeric transition in Sn^{119m} (250 days). G. SCHARFF-GOLDHABER, E. DER MATEOSIAN, M. GOLDHABER, G. W. JOHNSON AND M. MCKEOWN. Letter in *Phys. Rev.*, **83**, 480 (*July* 15, 1951).

A NaI–Tl crystal containing Sn^{119m} was grown by the Hofstadter method and scintillation pulses from it, due to the sum of the conversion electron energies, were observed with an oscilloscope. The decay to the ground state is believed to be by γ's of $65{\cdot}3 \pm 0{\cdot}5$ followed by 20 ± 5 KeV. F. R. HOLT

539.163.2

8920. Isomeric state of Y^{89} and the decay of Zr^{89}. M. GOLDHABER, E. DER MATEOSIAN, G. SCHARFF-GOLDHABER, A. W. SUNYAR, M. DEUTSCH AND N. S. WALL. Letter in *Phys. Rev.*, **83**, 661 (*Aug.* 1, 1951).

An isomeric state of energy 0·92 MeV and half-life 14 ± 2 sec has been produced by fast neutron bombardment of Y, and by separation from Zr^{89}.

B. ROSE

539.163.2

8921. The isomeric level of Cd^{111m}. C. L. MCGINNIS. Letter in *Phys. Rev.*, **83**, 686 (*Aug.* 1, 1951).

Cd^{111m} decays by a 149- followed by a 247-keV γ. The γ ratio is found experimentally to be $0{\cdot}33 \pm 0{\cdot}06$, and the 396-keV level is $h_{11/2}$. F. R. HOLT

539.163.2

8922. 24-minute radiations from Ag^{106}. W. L. BENDEL, F. J. SHORE AND R. A. BECKER. Letter in *Phys. Rev.*, **83**, 677 (*Aug.* 1, 1951).

Ag^{106} obtained by the bombardment of Ag foils with 22 MeV X-rays was examined in a semi-circular focusing magnetic spectrometer. Ag^{106} ($\frac{1}{2}$-life $24{\cdot}0 \pm 0{\cdot}2$ min) probably decays by positron emission to Pd^{106*} ($E\beta^+_{max} = 1{\cdot}5 \pm 0{\cdot}1$ MeV, intensity 0·29) and to Pd^{106} ($E\beta^+_{max} = 1{\cdot}945 \pm 0{\cdot}015$ MeV, intensity 0·71). There may also be an emission of negative electrons ($E_{max} = 0{\cdot}45 \pm 0{\cdot}10$ MeV, intensity $\sim 0{\cdot}02$). A. O. STANESBY

539.163.

8923. Radioactive decay of I^{131}. E. W. EMERY. Letter in *Phys. Rev.*, **83**, 679 (*Aug.* 1, 1951).

Suggests as decay scheme of I^{131} an extension of that of Metzger and Deutsch [Abstr. 2700 (1949)] which differs considerably from that of Cork *et al.* [Abstr. 4647 (1951)]. A. O. STANESBY

539.163.

8924. 4·4-Minute radiations from Zr^{89}. F. J. SHORE W. L. BENDEL AND R. A. BECKER. Letter in *Phys. Rev.*, **83**, 688 (*Aug.* 1, 1951).

The half-life was found to be $4{\cdot}4 \pm 0{\cdot}1$ min, the γ energy 588 ± 5 keV, and the total conversion coefficient $0{\cdot}07 \pm 0{\cdot}02$. The transition is probably magnetic 2^4-pole. A suggested partial level scheme is given. F. R. HOLT

539.163.

8925. The positron to γ-ray ratio in Zn^{65}. G. M. GRIFFITHS. Letter in *Phys. Rev.*, **83**, 852 (*Aug.* 15, 1951).

A ratio of $1 : 65 \pm 5$ is estimated from coincidence measurements. J. J. WILKIN

539.163.1

8926. The radioactivity of barium^{140}. J. M. CORK J. M. LEBLANC, A. E. STODDARD, D. W. MARTIN C. E. BRANYAN AND W. J. CHILDS. Letter in *Phys. Rev.*, **83**, 856 (*Aug.* 15, 1951).

Accurate photographic magnetic spectrometer observations of the electron energies associated with the Ba^{140} activity lead to a level assignment for La^{14} which shows the existence of previously unreported γ-rays. W. J. SWIATECK

539.163.

8927. A proton-gamma-ray coincidence study of Si^{3} and B^{11}. H. H. LANDON. *Phys. Rev.*, **83**, 1081– (*Sept.* 15, 1951).

The excited states of the Si^{30} and B^{11} nuclei were studied by means of a proton/gamma-ray coincidence technique for the purpose of determining the nature of the gamma-ray decay scheme. The nuclei were formed under cyclotron bombardment using the $Al^{27}(\alpha, p)Si^{30}$ and $B^{10}(d, p)B^{11}$ reactions. The transitions from the first two excited states of Si^{30} are directly to the ground state, while the transition from the third excited state takes place by means of a cascade to the second state and then to the ground state. The decay scheme in the B^{11} nucleus is most likely the same as for the Si^{30} nucleus for the first two excited states, while the third and the prolific fifth and sixth states show cascade transitions as most probable.

A

539.163.

8928. The disintegration scheme of Au^{199}. P. M. SHERK AND R. D. HILL. *Phys. Rev.*, **83**, 1097–110 (*Sept.* 15, 1951).

The disintegration of 3·3-day Au^{199} has been investigated using beta-ray spectrometers and counting techniques. The beta-ray spectrum was observed to be complex. Determinations were made of the conversion electron and γ-ray intensities of three

γ-transitions of 50, 159 and 209 keV. A consistent disintegration scheme is given. A.

539.163.2, 539.165

8929. Disintegration of Ce^{143} and Pr^{143}. E. KONDAIAH. Letter in *Phys. Rev.*, **83**, 471 (*July* 15, 1951).

Pile-irradiated Ce was studied. The β-spectrum within 24 hours showed 5 or 6 components. A decay scheme is proposed. F. R. HOLT

539.165

8930. An absolute determination of the *F*, *I*, and *L* lines of Th($B + C + C''$). G. LINDSTRÖM. Letter in *Phys. Rev.*, **83**, 465 (*July* 15, 1951).

A semi-circular β spectrograph was used. $H\rho$ for the lines was measured as $1388 \cdot 55 \pm 0 \cdot 20$, $1754 \cdot 01 \pm 0 \cdot 25$ and $2607 \cdot 18 \pm 0 \cdot 35$ gauss cm respectively. This indicates that the β^- and β^+ masses are the same. F. R. HOLT

539.165

8931. A note on the beta-decay of F^{17}. H. T. RICHARDS. Letter in *Phys. Rev.*, **83**, 694 (*Aug.* 1, 1951),

Adduces arguments for questioning the reported beta-decay of F^{17} [Abstr. 2947 (1951)] and suggests contamination by F^{18} as the cause of the trouble. A. O. STANESBY

539.165

8932. The beta spectrum of S^{35} using window corrections. R. B. HELLER, E. F. STURCKEN AND E. H. WEBER. Letter in *Phys. Rev.*, **83**, 848 (*Aug.* 15, 1951).

A very thin CdS^{35} source on < 10 $\mu g/cm^2$ Al coated Nylon backing, was examined in a thin magnetic lens spectrometer with a 45 $\mu g/cm^2$ Nylon window counter. Using the known transmission properties of the counter window, corrections were made to the observed β spectrum, resulting in a Fermi plot which was linear down to 32 keV. L. R. SHEPHERD

539.165, 539.166

8933. Measurement of the radiations from ^{131}I and $^{131}Xe^*$ with a lens type beta-ray spectrometer. N. F. VERSTER, G. J. NIJGH, R. VAN LIESHOUT AND C. J. BAKKER. *Physica*, **17**, 637–57 (*July*, 1951).

See Abstr. 265 (1944); 5 (1945); 2700 (1949). A description is given of the construction of a lens type spectrometer with an annular exit slit. An experimental method for the adjustment of this slit is described. The instrument has a transmission of 1% and a line width of 2, 3 and 4% for sources of 3, 6 or 9 mm diameter. The influence of radiator thickness on the shape of photo-electron lines has been studied. The beta and gamma ray spectra of 8·0 day I^{131} have been investigated as well as the conversion spectrum of Xe^{131*}. Photo-electrons ejected from Pb and U by gamma rays of 80, 284, 364 and 636·5 keV have been found. Internal conversion electrons from all these gamma rays are present. In sources which have aged for some days conversion electrons from the 163 keV gamma ray of 12 day Xe^{131*} appear also. These conversion electrons have also been observed in the conversion spectrum of Xe gas extracted from a I^{131} sample. In the beta spectrum of I^{131} two components of maximum energies 606 and 334 keV are easily found, both yielding straight Kurie plots. In addition a very weak third component has been detected which is assumed to lead to the metastable Xe level. Also a very weak internal conversion line is found at 690 keV corresponding to a hitherto unknown gamma ray of 724 keV. The level scheme of Metzger and Deutsch [Abstr. 2700 (1949)] is confirmed. A consistent spin and parity assignment to the levels is possible, the 606 keV beta transition being allowed despite its high *ft*-value of $4 \cdot 5 \times 10^6$.

539.165, 539.166

8934. On the decay of I^{131}. S. THULIN. Letter in *Phys. Rev.*, **83**, 860 (*Aug.* 15, 1951).

Measurements of β- and γ-ray energies and coincidences are reported. J. J. WILKINS

539.165 : 539.166

8935. Energy dependence of the beta-gamma angular correlation in Sb^{124}. E. K. DARBY AND W. OPECHOWSKI. Letter in *Phys. Rev.*, **83**, 676 (*Aug.* 1, 1951).

The integrated angular correlation was first measured, and fitted a curve $(1 - 0 \cdot 23 \cos^2 \theta)$. The differential angular correlation measurements are plotted against the β energy. F. R. HOLT

539.165, 539.166

8936. Radiations from Br^{77} and Ni^{57}. R. CANADA AND A. C. G. MITCHELL. *Phys. Rev.*, **83**, 955–9 (*Sept.* 1, 1951).

The nuclear spectra of Br^{77} (58 hr) and Ni^{57} (36 hr) have been investigated in a magnetic lens spectrograph. Br^{77} decays by orbital electron capture and positron emission to Se^{77}, Br^{77} emits a single positron group of energy 0·336 MeV together with gamma-rays of energy 0·160, 0·237, 0·284, 0·298, 0·520, 0·641 and 0·813 MeV, of which the lines at 0·160, 0·237 and 0·520 MeV are internally converted. Br^{77} is the parent of the metastable state Se^{77m} of 17-sec half-life, and the energy of the gamma-ray associated with this transition is 0·160 MeV. The radiations from Ni^{57} consist of one positron group whose end point is 0·835 MeV together with one strong gamma-ray of energy 1·375 MeV and two weaker gamma-rays whose energies are 1·91 and 0·128 MeV, the latter being internally converted. A.

539.165 : 539.166

8937. Electron–gamma–angular correlation measurements in radioactive decay. D. T. STEVENSON AND M. DEUTSCH. *Phys. Rev.*, **83**, 1202–7 (*Sept.* 15, 1951).

The beta–gamma angular correlations in the decay of a number of nuclides have been studied as a function of the beta-ray energy. Isotropic correlations were found in the decay of Co^{55}, Co^{56}, Co^{60}, Na^{22}, Na^{24}, Cs^{134} and I^{124}. Non-isotropic correlations have been measured in the decay of Rb^{86}, Sb^{124} and I^{126}. The interpretation of these results in terms of the properties of the emitted radiations and the nuclear energy states is discussed. A non-isotropic conversion electron–gamma–angular correlation was found in the decay of Mo^{93}. A.

539.165.2

8938. On the spin of neutrino. K. ONO. *Progr. Theor. Phys.*, **6**, 238–43 (*March–April*, 1951).

It is shown that neutrinos of spin other than $\frac{1}{2}$ lead to β-decay spectra which are inconsistent with Fermi allowed transitions and experiment. J. R. MADDOX

539.166

8939. On the γ-radiation of $^{82}_{35}$Br. P. HUBERT AND J. LABERRIGUE-FROLOW. *C.R. Acad. Sci., Paris*, **232**, 2420–1 (*June* 25, 1951) *In French.*

Photoelectrons ejected from Au and Pb by the γ-rays of Br^{82} obtained as NaBr from the slow neutron bombardment of $CHBr_3$ (Szilard–Chalmers) were examined in a thick lens spectrograph, and an additional line, corresponding to a γ-ray of energy 1 453 ± 6 keV, was found [see also Siegbahn *et al* Abstr. 1971 (1950)]. The intensity was about ¼ that of the line at 1·3 MeV. A. O. STANESBY

539.166

8940. Scintillation spectroscopy of the gamma-rays from slow neutron capture in manganese. R. W. PRINGLE AND G. ISFORD. Letter in *Phys. Rev.*, **83**, 467 (*July* 15, 1951).

A 50 mC Ra–Be source and a c.r.t. photographic system resulted in 3% resolution. γ-rays from Mn^{55} were 5·32 and 7·16 MeV. F. R. HOLT

539.166

8941. Gamma-radiation from I^{132}. F. C. MAIENSCHEIN, J. K. BAIR AND W. B. BAKER. Letter in *Phys. Rev.*, **83**, 477 (*July* 15, 1951).

Energy measurements used NaI crystals in 3 methods. A single-crystal spectrometer gave γ's of energy 0·67, 1·41 and 1·99 MeV with relative intensities of 37 : 4 : 1. The first two γ's are in coincidence. F. R. HOLT

539.166

8942. Scintillation counter studies of neutron capture gamma ray spectra. B. HAMERMESH AND V. HUMMEL. Letter in *Phys. Rev.*, **83**, 663 (*Aug.* 1, 1951).

NaI crystals have been used for this purpose, and data are given for Al, Cl, Fe and Mn. B. ROSE

539.166

8943. Gamma-radiation associated with radium and daughter products. J. M. CORK, C. E. BRANYAN, A. E. STODDARD, H. B. KELLER, J. M. LEBLANC AND W. J. CHILDS. Letter in *Phys. Rev.*, **83**, 681 (*Aug.* 1, 1951).

Photo- and internal-conversion electrons from Ra and its daughter products were examined in spectrometers calibrated against I^{131} γ-rays. 63 electron lines were examined and assigned to 18 γ-rays. Accuracy is not given. A. O. STANESBY

539.166

8944. The energy of the metastable state of Ba^{135}. W. H. CUFFEY AND R. CANADA. Letter in *Phys. Rev.*, **83**, 654 (*Aug.* 1, 1951).

The γ energy was measured with a scintillation counter, and the internal conversion electron energy with a magnetic lens spectrometer. A 267-keV γ was found, also peaks corresponding to *K* and *L* conversion for a line of this energy. F. R. HOLT

539.166

8945. Disintegration of Sn^{119m}. R. D. HILL. Letter in *Phys. Rev.*, **83**, 865 (*Aug.* 15, 1951).

γ-rays of 24·2 ± 0·5 keV and 65·3 ± 0·5 keV were observed with approximately equal intensities. J. J. WILKINS

539.16

8946. Two-step isomeric transition in Hf^{179m}. E. DER MATEOSIAN AND M. GOLDHABER. Letter in *Phys. Rev.*, **83**, 843 (*Aug.* 15, 1951).

Coincidence studies of electrons and γ's confirm the existence of a highly internally converted 160-kV transition and a weakly converted 215-keV one. The former is deduced to be magnetic 2^3-pole and the latter corresponds to spin change ⩽ 2, with magnetic 2^2-pole excluded. W. J. SWIATECKI

539.166.

8947. Nuclear isomers of Ba^{133} and Ba^{135}. R. D. HILL AND F. R. METZGER. Letter in *Phys. Rev.*, **83**, 455 (*July* 15, 1951).

$BaCO_3$ enriched in Ba^{134} was pile-irradiated. *K* and *L* conversion lines of 269 ± 2 keV were found with a half-life of 30 hr, an N_K/N_L ratio of about 2 and a *K* conversion coefficient of 3·5 ± 1·5. Ba^{133m} sources showed *K*, *L* and *M* conversion lines from a 275·5 ± 1 keV γ transition. The *K* conversion coefficient was 3 ± 1. F. R. HOLT

539.166.

8948. Polarization of gamma radiation following capture of polarized neutrons. L. C. BIEDENHARN, M. E. ROSE AND G. B. ARFKEN. Letter in *Phys. Rev.*, **83**, 683 (*Aug.* 1, 1951).

The radiation should be circularly polarized, the different intensities of right and left polarizations being demonstrable by the use of magnetized iron as Compton scatterer. B. ROSE

539.166.

8949. Coincidences in GM-counters due to single gamma-photons. J. GIERULA. Letter in *Acta Phys. Polon.*, **10** (*No.* 3–4) 299–300 (1951).

A filtered (2·5 cm Pb) collimated beam of ThC γ-rays was allowed to fall on to a G.M. counter; a second counter in coincidence with it to detect scattered photons could be rotated about the axis of the first. The coincidence rate was investigated as a function of the angle between the incident beam and the second counter; there was a max. at about 25°. The exptl. pts. agree well with a curve calc. from the Klein–Nishima scattering formula. A. O. STANESBY

539.166.

8950. High energy bremsstrahlung and pair production. J. W. DEWIRE AND L. A. BEACH. Letter in *Phys. Rev.*, **83**, 476 (*July* 15, 1951).

The energy spectrum of photons from the Cornell synchrotron was observed up to 312 MeV with a magnetic lens spectrometer. Some data on energy sharing in electron pairs are also given. F. R. HOLT

539.166.8

8951. A study of the internal conversion radiation of ionium. P. FALK-VAIRANT AND J. TEILLAC. *J. Phys. Radium*, **12**, 659–64 (*June*, 1951) *In French.*

Coincidence measurements show that for each 100 disintegrations of Io, 22 electrons are emitted from the 68 keV, excited level of Ra. This result is in agreement with the value obtained from the study of the α-particle fine structure and the γ-radiation. J. HUGHES

539.166.83

8952. Measurement of some internal conversion coefficients. A. W. SUNYAR. Letter in *Phys. Rev.*, **83**, 864 (*Aug.* 15, 1951).

These were measured for Cd^{111m}, Cs^{134m}, Ta^{182m} using a NaI scintillation counter, and the results are compatible only with electric 2^3-pole transitions in spite of the long lifetimes. W. J. SWIATECKI

539.166.835

8953. Angular correlation of annihilation radiation from positrons decaying in several substances. J. B. WARREN AND G. M. GRIFFITHS. *Canad. J. Phys.*, **29**, 325–35 (*July*, 1951).

Using anthracene scintillation counters in coincidence, the angular correlation between annihilation quanta produced by the decay of positrons in the following materials has been measured: the pure elements Mg, S, Cu, Sn, Pt, and Hg, and the chemical compounds LiCl, KCl, CsCl, KF and KI. Calculations were performed to determine the effect of the geometry on the shape of the angular correlation curves, and the effects of scattering were investigated. The curves for Cu, Pt and possibly Hg could be approximated to by the expression $C(\theta) = Ke^{-\theta/\theta_0}$, where $C(\theta)$ is the coincidence counting rate as a function of θ, the angular departure of the two quanta from collinearity, and K and θ_0 are constants. The curves for the other materials are more complicated and suggest that there is a relation between the shape of the curves and the outer electronic structure of the atoms with which the positrons annihilate. In alkali halides the positrons appear to annihilate only against the outer electrons of the negatively charged halogen ions. A.

539.167

8954. Some aspects of the behaviour of carrier-free tracers. I. N. A. BONNER AND M. KAHN. *Nucleonics*, **8**, 46–59 (*Feb.*, 1951).

Deals with the coprecipitation of tracer quantities of radioisotopes with non-isotopic carriers. Four processes, classified by Hahn, are described: isomorphous replacement, in which the tracer atoms are isomorphously incorporated into the crystal lattice of the carrier; adsorption of the tracer on the surface of the precipitate; anomalous mixed crystal formation; internal adsorption processes where the tracer is adsorbed on the surfaces of growing crystals, and hence incorporated in the crystal in a discontinuous manner. In the case of isomorphous replacement the distribution of tracer between solution and precipitate may be homogeneous, i.e. the ratio of tracer to carrier in the precipitate is proportional to that in the solution; or a logarithmic distribution law may be followed when log (total tracer/tracer in solution) $\propto$ log (total carrier/carrier in solution). The latter leads to more efficient precipitation of the tracer than does the former, and it is brought about by rapid precipitation from a supersaturated solution of the carrier followed by quick separation from the liquid. L. R. SHEPPARD

539.167

8955. Some aspects of the behaviour of carrier-free tracers. II. N. A. BONNER AND M. KAHN. *Nucleonics*, **8**, 40–61 (*March*, 1951).

Further methods of depositing carrier-free tracers: absorption by counter-ion exchange and isomorphous replacement on pre-formed ionic precipitates. The determination of oxidation potentials of couples which involve free tracers by means of critical deposition potential measurements is discussed, and results are tabulated for a number of couples. Methods of chemical separation of carrier-free tracers by electrical migration, and of determining the charge on tracer ions by observation of electrical migration and diffusion rates are described briefly. The validity of extrapolation from behaviour in tracer amounts to behaviour in macroconcentrations is examined. L. R. SHEPHERD

NUCLEAR REACTIONS 539.17

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 8814, 8818, 8824–30.

539.172

8956. Excitation of nuclei under the influence of fast electrons. K. TER-MARTIROSYAN. *J. Exp. Theor. Phys., USSR*, **20**, 925–36 (*Oct.*, 1950) *In Russian.*

The cross-section for the "zero" transition is calculated using accurate Coulomb functions. For the 2^n multipole transition it is determined in Born approximation; the influence of the nuclear field on the excitation probability near the reaction barrier is also examined. J. JACOBS

539.172.11

8957. The reactions of $He^3 + He^3$. W. M. GOOD, W. E. KUNZ AND C. D. MOAK. Letter in *Phys. Rev.*, **83**, 845 (*Aug.* 15, 1951).

The proton energy distribution in the reaction He^3 (beam of a Cockroft–Walton generator) + He^3 (deposited by the beam on Al foil) = $He^4 + 2H^1 +$ 12·82 MeV follows the predicted 3-body break-up spectrum except for some deviations which suggest competing reactions. W. J. SWIATECKI

539.172.11

8958. Measuring of Q-values for $(\alpha\ p)$-reactions on aluminium and boron by means of photographic emulsions. H. SLÄTIS, E. HJALMAR AND R. CARLSSON. *Ark. Fys.*, **3**, *Paper* 17, 315–35 (1951).

Previous Q-values are presented in tables and figures. Those for the B(α, p)C-reaction are inconsistent and require new investigations. A new arrangement for measuring Q-values by means of modern photographic nuclear research emulsions and a polonium α-particle source is described. Results for the Al(α, p)Si-reactions were 1·24, 0·14 and 2·30 MeV, and for the B(α, p)C-reactions were −1·75, −0·55, 0·00 and 0·63 MeV. The value 0·00 MeV may, however, be a mean of two or more unresolved Q-values. A.

539.172.13

8959. Neutron thresholds from the reactions $T^3(p,n)He^3$, $Li^7(p,n)Be^7$, $Be^9(d,n)^*B^{10}$, and $O^{16}(d,n)F^{17}$. T. W. BONNER AND J. W. BUTLER. *Phys. Rev.*, **83**, 1091–6 (*Sept.* 15, 1951).

Techniques are described for observing low

energy (15–60 keV) "threshold" neutrons in the presence of fast neutrons. The threshold of the $T^3(p, n)He^3$ reaction was found to be 1 020·3 keV, which gives a Q-value of the reaction equal to −764·7 keV and a neutron-hydrogen mass difference of 783·2 keV. Interpretation of data near the threshold of the $Li^7(p, n)Be^7$ reaction gives indication of a level in Be^8 near 18·90 MeV. Three neutron thresholds have been observed in the reaction $Be^9(d, n)^*B^{10}$ at deuteron energies of 920, 985 and 1 916 keV. The corresponding Q-values are −752, −805 and −1 566 keV; these give excited states in B^{10} at 5·110, 5·163 and 5·924 MeV. The threshold of the reaction $O^{16}(d, n)F^{17}$ was determined to be 1 836 keV, giving a Q-value of −1 631 keV and a mass of F^{17} equal to 17·007506. A.

539.172.13

8960. Cross-section for the reaction $^9Be(p, p2n)^7Be$ at 156 MeV. T. C. Randle, J. M. Dickson and J. M. Cassels. Note in *Phil. Mag.*, **42**, 665 (*June*, 1951).

This was found to be $9·2 \pm 0·9 \times 10^{-27}$ cm² by comparison with activities of C and Be targets.

W. J. SWIATECKI

539.172.13

8961. Excitation curve for the $H^3(p, \gamma)He^4$ reaction. C. E. Falk and G. C. Phillips. Letter in *Phys. Rev.*, **83**, 468 (*July* 15, 1951).

Proton energies between 1·0 and 3·4 MeV were used, and the γ's emitted at 90° ± 25° were observed with a scintillation counter. No resonance was found. F. R. HOLT

539.172.13

8962. On the angular distribution of π^+ mesons from 341-MeV protons on protons. M. N. Whitehead and C. Richman. Letter in *Phys. Rev.*, **83**, 855 (*Aug.* 15, 1951).

The cross-section for the $p + p \rightarrow d + \pi^+$ reaction at 60° (laboratory frame) was measured and combined with previous measurements at 0°, 18° and 30° to deduce an approximately $\cos^2\theta$ distribution suggesting that most π^+ come off in a P-wave. W. J. SWIATECKI

539.172.13

8963. Elastic scattering of 340-MeV protons. R. E. Richardson, W. P. Ball, C. E. Leith and B. J. Moyer. Letter in *Phys. Rev.*, **83**, 859 (*Aug.* 15, 1951).

Preliminary angular distributions with C, Cu and Pb targets show some agreement with the diffraction patterns predicted by the "transparent nucleus theory" of Fernbach, Serber and Taylor [Abstr. 5006 (1949)]. W. J. SWIATECKI

539.172.13

8964. Nuclear reactions resulting from the proton bombardment of aluminum. F. C. Shoemaker, J. E. Faulkner, G. M. B. Bouricius, S. G. Kaufmann and F. P. Mooring. *Phys. Rev.*, **83**, 1011–17 (*Sept.* 1, 1951).

The energy dependence of reaction product yields from Al bombarded by protons has been measured in the energy range from 1·4 to 4 MeV with fairly high energy resolution. Yield curves are shown for elastically scattered protons, alpha-particles (both full energy and those leaving the residual nucleus Mg^{24} in the first excited state), gamma-radiation, and, over a limited range, inelastically scattered protons leaving the residual nucleus Al^{27} in the first two excited states. The gamma-ray yield at proton energies above 2 MeV is shown to be principally from the excited residual nuclei. All reactions show a pronounced resonance structure. A.

539.172.13

8965. The reaction $C^{14}(p, n)N^{14}$: Excited states in N^{15}. W. D. Roseborough, J. J. G. McCue, W. M. Preston and C. Goodman. *Phys. Rev.*, **83**, 1133–6 (*Sept.* 15, 1951).

The relative neutron yield from $C^{14}(p, n)N^{14}$ has been measured for proton energies of 1 100 to 2 600 keV. Resonances occur at nine proton energies: 1 165, 1 310, 1 664, 1 789, 1 883, 2 024, 2 079, 2 272 and 2 451 keV. The form of the yield curve and the calculated energies of the resonance levels in N^{15} are in good agreement with the results of others on the inverse reaction, $N^{14}(n, p)C^{14}$. A.

539.172.13

8966. Carrier-free radioisotopes from cyclotron targets. XVII. Preparation and isolation of Fe^{59} from cobalt. J. D. Gile, W. M. Garrison and J. G. Hamilton. Letter in *J. Chem. Phys.*, **19**, 1217 (*Sept.*, 1951). For Pt XVI, see Abstr. 5751 (1951).

539.172.13

8967. Carrier-free radioisotopes from cyclotron targets. XVIII. Preparation and isolation of Cr^{51} from vanadium. J. D. Gile, W. M. Garrison and J. G. Hamilton. Letter in *J. Chem. Phys.*, **19**, 1217 (*Sept.*, 1951).

539.172.13

8968. Exchange collisions of fast nucleons with deuterons. I. Pomeranchuk. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 2) 249–50 (1951) *In Russian.*

Theoretical. The influence of the di-neutron and di-proton states is discussed. E. P. GEORGE

539.172.13

8969. Neutron thresholds in light elements. E. B. Tucker. Letter in *Phys. Rev.*, **83**, 473 (*July* 15, 1951).

Neutron thresholds obtained by bombardment with 0–3·5 MeV deuterons of Li, Be, B (natural and enriched), C and PbF_2 were investigated. F. R. HOLT

539.172.13

8970. Low states of F^{17} and neutrons from O^{16} + D. F. Ajzenberg. Letter in *Phys. Rev.*, **83**, 693 (*Aug.* 1, 1951).

A thin tungsten oxide target was bombarded with 3·083 MeV deuterons, and 1 700 nuclear emulsion tracks were measured at various angles to the beam. Neutron groups corresponding to a first excited state of F^{17} at 536 ± 10 keV were observed. F. R. HOLT

539.172.13

8971. Angular distributions for (d, p) and (d, n) reactions in light nuclei. S. T. Butler and J. L. Symonds. Letter in *Phys. Rev.*, **83**, 858 (*Aug.* 15, 1951).

Recent experimental data for the reactions $H^3(d, n)He^4$ and $He^3(d, p)He^4$ are explained by the stripping process. J. J. WILKINS

539.172.13

8972. Erratum: Angular distribution of protons from the $D(d,p)T$ reaction at 10·3-MeV bombarding energy. J. C. ALLRED, D. D. PHILLIPS AND L. ROSEN. Letter in *Phys. Rev.*, **83**, 1077 (*Sept.* 1, 1951). See Abstr. 8189 (1951).

539.172.13

8973. Angular distributions from (d,p) and (d,n) nuclear reactions. S. T. BUTLER. *Proc. Roy. Soc. A*, **208**, 559–79 (*Sept.* 24, 1951).

Experimental angular distributions from (d,p) and (d,n) nuclear reactions involve contributions from incident angular momenta much higher than is compatible with compound nucleus formation, and indicate that these reactions must proceed to a large extent by means of a stripping process. The angular distributions to be expected from a stripping process are calculated, and these are found to be very sensitive to the angular momenta which can be accepted by the initial nucleus, i.e. to the spins and parities of the energy levels involved. In any one case there is found excellent agreement between the experimental curve and just one of the possible theoretical curves, and if the spin and parity of the ground state of the initial nucleus is known, this allows of a determination of the spin and parity of the appropriate level of the final nucleus. In this way it is found, for example, that the ground state of O^{17} has spin $\frac{5}{2}$ or $\frac{3}{2}$ and even parity, and that the first excited state of O^{17} (0·88 MeV above ground) has spin $\frac{1}{2}$ and even parity. Determinations are also made of the spins and parities of the ground states and several excited states of C^{13}, N^{15} and Al^{28}. Families of theoretical curves for a variety of incident and outgoing energies are presented in order to facilitate further spin and parity determinations from future experimental results. A.

539.172.3

8974. The reactions $^{11}B(\gamma\alpha)^7Li$ and $B^{11}(\gamma T)^8Be$. M. E. CALCRAFT AND E. W. TITTERTON. Note in *Phil. Mag.*, **42**, 666–9 (*June*, 1951).

Microphotographs of the reaction $B^{11} + h\nu = He^4 + Li^7 - 8{\cdot}6$ MeV as well as of $B^{11} + h\nu = H^3 + 2He^4 - 11{\cdot}1$ MeV and $B^{11}(\gamma T)Be^{8*}$, $Be^{8*} \rightarrow 2He^4$ were obtained and analysed in terms of the 2·9 and 4·0 MeV levels of Be^8. No evidence for a Li^7 level below 7·38 MeV was found.

W. J. SWIATECKI

539.172.3

8975. Photoprotons from argon under the action of gamma-rays of 17·6 MeV. D. H. WILKINSON AND J. H. CARVER. Letter in *Phys. Rev.*, **83**, 466 (*July* 15, 1951).

The measured anomalously large (γ,p) cross-section for A^{40}, 5·4 mbarns cannot result from a surface photo-electric effect or from Schiff's suggestion [Abstr. 2943 (1948)] that high emission energies are favoured. F. R. HOLT

539.172.3

8976. Analysis of high energy proton spectra by means of a stack of photographic plates. D. WALKER. *Rev. Sci. Instrum.*, **22**, 607–11 (*Aug.*, 1951).

Stacks of photographic plates have been used to analyse the continuous spectrum of high energy protons emitted by a C target bombarded with γ-rays from an electron synchrotron. The planes of successive plates in a stack lay at 30° to a line through plate and target centres, and the plates were interleaved with Al absorbers. The numbers of proton tracks per cm² in the emulsions of successive plates yield an integral spectrum of the protons. Protons with energies up to > 120 MeV were present when the synchrotron was operated at 195 MeV. The effects of multiple scattering of the protons in the stacks are discussed, and it is shown how the tracks of protons originating from the target can be distinguished clearly from a background of randomly oriented tracks. A.

539.172.3

8977. Photoproduction of mesons in deuterium. G. MORPURGO. *Nuovo Cim.*, **8**, 552–68 (*Aug.*, 1951) *In Italian.*

The effect of binding and particularly of Pauli's principle in the photoproduction of mesons in deuterium has been studied independently of a detailed meson theory. This is possible by considering not the total cross-section, but only the ratio between the cross-sections for photoproduction in deuterium and hydrogen. A table (for photons of 300 MeV) shows that Pauli's principle considerably reduces the cross-section for photoproduction at small angles (down to $\sim 25°$) if the probability γ^2 that the spin of one of the nucleons is not flipped during the process is 1. On the contrary the effect of Pauli's principle is unimportant if the probability of flipping is 1. One can hope on the basis of these results that the experiment might decide between a large or small probability of flipping, so confirming the results of Panofsky *et al.* on the non-radiative absorption of mesons in deuterium. A.

539.172.3

8978. On low energy X-ray absorption by nuclei. R. H. MCFARLAND. Letter in *Phys. Rev.*, **83**, 666 (*Aug.* 1, 1951).

From absorption and activation measurements, an upper limit for nuclear resonance absorption in Ag, Rb and Sr in the energy range up to 100 keV was found to be 50 barns. B. ROSE

539.172.3

8979. Production of neutral mesons by γ-rays incident on hydrogen. A. SILVERMAN AND M. STEARNS. Letter in *Phys. Rev.*, **83**, 853 (*Aug.* 15, 1951).

Measurements of the differential cross-section at 60° and 90° (laboratory angles) are reported, for γ-ray energies between 200 and 310 MeV.

J. J. WILKINS

539.172.4

8980. (n,n) and (n,p) resonances in P^{31} and S^{32}. R. RICAMO. *Nuovo Cim.*, **8**, 383–402 (*June*, 1951) *In Italian.*

Total cross-sections for P^{31} and S^{32} have been measured for neutrons with energy ranging from 1·90 to 3·66 MeV. For the same neutron energies, the cross-sections for the (n,p) reaction have been remeasured for P^{31} with the β-activation method. Resonances for σ_t and $\sigma(n,p)$ in S^{32} occur at the same energies up to 3 MeV. In P^{31} the positions of the resonance coincide very closely up to 2·5 MeV; at higher energies, however, the coincidence ceases.

The energy of the neutron in both experiments [σ_t and $\sigma(n, p)$] is rigorously determined in the same way so that no systematic error may occur. One must then conclude that at relatively low energies the experimental data are consistent with the conception of an intermediate nucleus for nuclear reactions. At higher energies a more complicated picture appears to be necessary. Transmission experiments for σ_t-determination are discussed in view of the unusual accuracy of the present measurements (1%). The computations of Rose and Shapiro for the optimum absorber thickness were repeated and extended to cover the case in which the statistical errors are negligible and only constant relative errors are present. Neutrons were detected with scintillation counters utilizing anthracene crystals and 1P21 photomultipliers. The source of monochromatic neutrons was the D, D reaction in heavy ice target, 80 keV thick. A.

539.172.4

8981. Total neutron cross sections of magnesium and silicon. R. E. Fields and M. Walt. Letter in *Phys. Rev.*, **83**, 479 (*July* 15, 1951).

Neutrons below 800 keV were used. Peaks were found for neutron energies of: for Si, 195 and 570; and for Mg, 85, 275 and 430 keV. Mg also gave small peaks at 22, 560 and 680 keV. F. R. HOLT

539.172.4

8982. The mechanism of *nD* capture. N. Austern. Letter in *Phys. Rev.*, **83**, 672 (*Aug.* 1, 1951).

Rough calculations, based on mechanisms additional to those previously considered [e.g. Abstr. 1069 (1948)] have been carried out, giving the experimental value of the capture cross-section. B. ROSE

539.172.4

8983. Resonant scattering of slow neutrons by cadmium. B. N. Brockhouse, D. G. Hurst and M. Bloom. Letter in *Phys. Rev.*, **83**, 840 (*Aug.* 15, 1951).

The ratio of scattering to absorption cross-section as a function of neutron energy in the range 0·02–0·4 eV (determined using BF_3 counters) agrees very well with the Breit–Wigner single level formula (resonance at 0·176 eV). W. J. SWIATECKI

539.172.4

8984. Resonant scattering in samarium and gadolinium. B. N. Brockhouse and D. G. Hurst. Letter in *Phys. Rev.*, **83**, 841 (*Aug.* 15, 1951).

Using the method of the preceding Abstr. it was found that for Sm the results are in good agreement with the Breit–Wigner single level formula (resonance at 0·096 eV, spin of $Sm^{152} = \frac{9}{2}$), but for Gd this formula seems inadequate. W. J. SWIATECKI

539.172.4

8985. Emission of long-range particles in the fast neutron ternary fission of U-238 and Th-232. E. W. Titterton. Letter in *Phys. Rev.*, **83**, 673 (*Aug.* 1, 1951).

Loaded nuclear plates were exposed to 2·5 MeV neutrons. Several ternary fissions were found, for both isotopes. The light particle appeared to be an α, emitted preferentially near to 90° from the heavy fragments. The ternary fission frequency was similar to that for U^{235} with slow neutrons. F. R. HOLT

539.172.4

8986. Disintegration of boron by fast neutrons. B. Petree, C. H. Johnson and D. W. Miller. *Phys. Rev.*, **83**, 1148–53 (*Sept.* 15, 1951).

The cross-section for the $B^{10}(n, \alpha)$ reaction was measured as a function of neutron energy from 0·35 to 2·6 MeV. The cross-section was found to lie below the $1/v$ extrapolation of the thermal cross-section except at a peak observed at 1·9 MeV. This peak has a width of about 400 keV and a maximum value of 0·53 barn. The total variation of the cross-section at the peak is 0·35 barn. The ratio of the number of disintegrations leading to the ground state of Li^7 to the number leading to the excited state increases smoothly from 0·2 at 0·35 MeV to a maximum of 2·3 at 1·9 MeV, and decreases again to 0·8 at 2·6 MeV. A.

ATOM AND MOLECULE BEAMS . MESONS . NEUTRONS 539.18

539.18

8987. Production of single mesons by γ-quanta. A. M. Baldin and V. V. Mikhaĭlov. *J. Exp. Theor. Phys., USSR*, **20**, 1057–63 (*Dec.*, 1950) *In Russian.*

The differential cross-section is calculated for the production of charged mesons for the scalar, pseudoscalar and vector (with tensor coupling) theory. The angular distribution is shown graphically for various γ-ray energies up to 340 MeV. E. P. GEORGE

539.18

8988. On the decay of charged π-meson into neutral meson on collision with proton and deuteron. V. B. Berestetskiĭ and I. Ya. Pomeranchuk. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 5) 803–6 (1951) *In Russian.*

Theoretical. The transition probabilities are calculated for pseudoscalar mesons and various couplings. E. P. GEORGE

539.18

8989. Production of vector π-mesons by high energy nucleon-nucleon collisions. K. Ioa. Letter in *Progr. Theor. Phys.*, **6**, 258–9 (*March–April*, 1951).

Calculation of cross-sections and energy spectrum. J. R. MADDOX

539.18

8990. On the double scattering of mesons by nucleons. M. Cini and L. A. Radicati. *Nuovo Cim.*, **8**, 542–51 (*Aug.*, 1951).

Differential and total cross-sections are given for the double scattering of pseudoscalar mesons by nucleons. The total cross-section is compared with that for the single scattering. The cross-section is also compared with that resulting from a more crude calculation using the method of Heitler and Nordheim. A.

539.18

8991. On the lifetime of the negative Pi-meson. L. M. Lederman, E. T. Booth, H. Byfield and J. Kessler. Letter in *Phys. Rev.*, **83**, 685 (*Aug.* 1, 1951).

A cyclotron beam and a cloud chamber were used.

Results include $\tau_{\pi^-} = 2{\cdot}92 \pm 0{\cdot}32 \times 10^{-8}$ sec for the rest-system lifetime; and $M_{\mu^-} = 209{\cdot}8 \pm 2{\cdot}2\, m_e$.

F. R. HOLT

539.18

8992. The effect of Bohr orbit binding on negative μ-meson β-decay. C. E. PORTER AND H. PRIMAKOFF. Letter in *Phys. Rev.*, **83**, 849 (*Aug.* 15, 1951).

The energy distribution of the electrons produced in β-decay of the μ-meson is calculated, the μ-meson decaying after capture to an atomic K-orbit. The maximum electron energy is thereby increased by a fraction $Z\alpha$.

R. H. DALITZ

539.18

8993. A photographic study of the $\pi^+ \rightarrow \mu^+ \rightarrow \beta^+$ decay process and the energy spectrum of the β^+. H. BRAMSON AND W. W. HAVENS, JR. Letter in *Phys. Rev.*, **83**, 861 (*Aug.* 15, 1951).

1 158 π–μ events with the μ-meson ending in the emulsion have been observed, and in every case the β^{-1}-particle was visible. In 6 cases the positron was annihilated. The positron energy spectrum displays non-zero cut-off at the high-energy end.

E. P. GEORGE

539.18

8994. Measurement of the positive π-meson lifetime. C. E. WIEGAND. *Phys. Rev.*, **83**, 1085–90 (*Sept.* 15, 1951).

The time intervals between the succession of events: stopping of a π^+ meson in a stilbene crystal, $\pi \rightarrow \mu$-decay and $\mu \rightarrow \beta^+$ decay are used to identify the pulses produced by π^+ mesons and to measure the mean life of the $\pi^+ \rightarrow \mu$-decay. For this mean life we find $(2{\cdot}58 \pm 0{\cdot}14) \times 10^{-8}$ sec.

A.

539.18

8995. On the reactions $\pi^+ + d \lessgtr p + p$. W. B. CHESTON. *Phys. Rev.*, **83**, 1118–22 (*Sept.*, 1951).

The reactions $\pi^+ + d \lessgtr p + p$ have been investigated in weak-coupling approximation. Using detailed balancing arguments it is shown that comparison of the total cross-sections for both processes at appropriate energies allows a unique determination of the spin of the charged π-meson independent of weak coupling theory. It is also shown that the angular distributions of the final state particles and the energy variation of the total cross-sections also provide information as to the charged π-meson spin.

A.

539.181

8996. Detection of the molecular beam on the basis of the change in the electrical conductivity of the [metallic] condensate. M. I. KORSUNSKIĬ, L. I. PIVOVAR AND A. M. MARKUS. *J. Exp. Theor. Phys., USSR*, **20**, 860–1 (*Sept.*, 1950) *In Russian.*

Demonstrates the possibility of designing a highly sensitive detector for molecular radiation, based on the change of the electrical conductivity of the metallic condensate when the substance from the molecular beam investigated is deposited on the condensate.

F. LACHMAN

539.181

8997. An indicator for molecular beams. A. M. MARKUS, L. I. PIVOVAR AND I. M. PODGORNYĬ. *J. Tech. Phys., USSR*, **21**, 155–9 (*Feb.*, 1951) *In Russian.*

Describes an indicator for molecular beams of substances for which the condensates (condensation deposits) are characterized by a considerable electric conductivity. It is claimed that this method is suitable for a wide range of rates of deposition. The apparatus is based on the relationship between the electric conductivity of the deposit and its thickness.

F. LACHMAN

539.181 : 539.132

8998. On wave nature of matter. B. MISHRA. *Indian J. Phys.*, **25**, 57–60 (*Feb.*, 1951).

The molecular beams obtained by vaporizing S and paraffin have been allowed to pass through a slit and condense on an ice-cooled glass plate. It is observed that the deposited pattern consists of parallel lines with their lengths parallel to the length of the slit. A tentative explanation is offered that the fringe system is produced by diffraction of a type of waves associated with the molecules at the slit. On this assumption the corresponding wavelengths have been calculated and have been found to be of the order of 0·027 mm in both the cases. Such a wavelength is different from de Broglie waves and is of the order of those corresponding to vibrations of the single molecules.

A.

541.183 : 531.724

8999. Surface area of porous adsorbents. Y. FU AND F. E. BARTELL. *J. Phys. Coll. Chem.*, **55**, 662–75 (*May*, 1951).

A method for the determination of the specific area of porous solids using only adsorption data and not involving the dimensions of the adsorbates has been presented and applied to porous glass, cellulose, ferric oxide, and silica gels. The results obtained by this method agree satisfactorily with those by the B.E.T. method.

A.

539.185

9000. Scattering of 3·27 MeV (d, d)-neutrons on deuterons in the Wilson chamber. I. HAMOUDA, J. HALTER AND P. SCHERRER. *Helv. Phys. Acta*, **24** (*No.* 3) 217–34 (1951) *In German.*

The angular distribution of 3·27 MeV (d, d) neutrons scattered by deuterons was investigated in the cloud chamber. To eliminate the disturbing effects of the neutrons scattered into the chamber from the surrounding material and to account for corrections due to the geometry of the apparatus, the angular distribution of neutron-proton scattering was also investigated with the same neutron source and under the same geometrical conditions. Assuming that the (n, p)-distribution is isotropic, a correction factor is obtained for the disturbing effects which is the deviation from isotropy of the measured distribution. In two separate runs of photographs under different geometrical conditions 5 000 proton-recoils and 10 000 deuteron recoils were investigated. The two independently measured (n, d)-angular distributions were found to agree well within the limits of statistical fluctuation. Our data show a pronounced maximum at neutron scattering angle of 180° which is about three times the minimum at 90° in centre of mass system. An extrapolation to 0° gives a maximum which is about 1·5 times the minimum.

539.185

9001. Angular distribution of 3·1 MeV neutrons scattered by protons. Y. ODA, J. SANADA AND S. YAMABE. *J. Phys. Soc. Japan*, **6**, 153–6 (*May–June*, 1951).

Redeterminations of the forward scattering (as given by observations of the neutrons rather than the recoil protons) indicate that it is not inconsistent with isotropic scattering. W. J. SWIATECKI

539.185

9002. On the scattering of "slow" neutrons by an isotropic harmonic oscillator. A. MESSIAH. *J. Phys. Radium*, **12**, 670–2 (*June*, 1951) *In French.*

The asymptotic expansion of the total cross-section for large energy E is calculated and it appears that only when the masses of oscillator and neutron are equal is the coefficient of $1/E$ oscillatory.

W. J. SWIATECKI

539.185

9003. The inelastic scattering of very slow neutrons by aluminium. J. M. CASSELS. *Proc. Roy. Soc. A*, **208**, 527–34 (*Sept.* 24, 1951).

The inelastic scattering of very slow neutrons by Al has been measured at four temperatures between 90 and 700°K. The results are compared with theory and found to agree within 10%. An appendix gives in compact form the theoretical expressions which have been adopted. A.

539.185

9004. Neutron-proton scattering with repulsive forces. P. O. OLSSON. Letter in *Phys. Rev.*, **83**, 845 (*Aug.* 15, 1951).

Comparison of experimental data at 90 MeV, 260 MeV and at low energies with the neutron-proton scattering due to a central square-well potential with an impenetrable core suggests that there is no strong repulsive core in neutron-proton interaction in even triplet states. R. H. DALITZ

539.185

9005. Neutron diffusion and the theory of atomic piles. A. ERTAUD. *Vide*, **6**, 966–73 (*March*, 1951) *In French.*

An account of the nuclear processes occurring in a chain-reacting pile with a survey of the elementary theory of diffusion and slowing down of neutrons in a moderator. The two-group derivation of the critical equation for a homogeneous pile, is outlined and the solutions quoted for an infinite slab, a sphere cube and right cylinder. L. R. SHEPHERD

539.185

9006. Neutron crystal monochromators. R. J. WEISS, J. HASTINGS AND L. CORLISS. Letter in *Phys. Rev.*, **83**, 863 (*Aug.* 15, 1951).

Considers the effect of the lineage structure of a monochromating crystal on the shape of the Bragg peaks and relates the results to the practical problem of finding good crystals. J. THEWLIS

539.185

9007. Neutron diffraction by the gases N_2, CF_4, and CH_4. N. Z. ALCOCK AND D. G. HURST. *Phys. Rev.*, **83**, 1100–5 (*Sept.* 15, 1951).

Neutron diffraction patterns are given for a neutron wavelength of 1·063 Å. It is found that the coherent scattering cross-sections of N and F are nearly equal to the total cross-sections, and that the C–F bond length in CF_4 is 1·33 Å. The error in a semiclassical form of the differential scattering cross-section is discussed. A.

539.185

9008. Thick target yields from the (d, n) reaction at 10 MeV. L. W. SMITH AND P. G. KRUGER. *Phys. Rev.*, **83**, 1137–40 (*Sept.* 15, 1951).

The neutron yield from thick targets of Be, B, C, Al, Ni, Cu, Mo, Ta, W, Pt and Au, bombarded with 10 MeV deuterons, has been determined by comparing the manganese activity ($MnSO_4$ in solution, in a large tank) after bombardment, with the activity produced by a standard Ra–Be source placed at the same position as the target. Some less reliable data on P, Mn and Sb, obtained by a different method, are included. A.

539.185 : 539.163

9009. Neutron decay: the problem and the experiments. A. H. SNELL. *Nucleonics*, **8**, 3–13 (*March*, 1951).

The successful experiments [Abstr. 6745–6 (1950)] are outlined. In both cases an intense, narrow beam of thermal neutrons from a reactor passed through a strong lateral electric field, any protons formed by β-decay of the neutrons being accelerated toward the side and detected by an electron multiplier. In Robson's experiment the protons passed first through a thin-lens magnetic spectrometer to separate protons from extraneous charged particles. Snell observed coincidences between decay protons and β-particles, with a 0·25 μsec delay in the β-counting line to allow for the time of flight of the protons from the neutron beam to the multiplier. Robson, using a lens spectrometer, measured the β-spectrum in coincidence with the protons, and found a Fermi allowed spectrum, with end point at 0·782 ± 0·013 MeV. Estimates of the neutron half-life : 8–20 min (Robson), 10–30 min (Snell). The importance of accurate measurements of this half-life is emphasized. Proposed alternative methods for observing neutron decay are described.

L. R. SHEPHERD

539.185 : 539.172.13

9010. A 200 kV neutron generator. N. G. SJÖSTRAND. *Appl. Sci. Res.*, **B2** (*No.* 3) 227–40 (1951).

The construction and operation of a 200 kV neutron generator utilizing the D–D reaction are described. The apparatus has been used for irradiation experiments requiring stable operation over a period of several hours. The average neutron intensity under such circumstances is about 10 C RaBe equivalent. A.

STRUCTURE OF SOLIDS 539.2

539.215.3

9011. The problem of the intercrystalline matter and the texture of the grain boundaries in metals. I. M. FEDORCHENKO. *J. Tech. Phys., USSR*, **21**, 196–205 (*Feb.*, 1951) *In Russian.*

539.217

9012. Anisotropy of diffusion in grain boundaries. M. R. ACHTER AND R. SMOLUCHOWSKI. Letter in *Phys. Rev.*, **83**, 163–4 (*July* 1, 1951).

The preferential diffusion of Ag along the grain boundaries of Cu is negligible for all angles between the grains less than 20° but becomes appreciable, although only for directions along the line of the edge dislocations forming the boundary, at angles greater than 20°, reaching a maximum at 45°. No preferential diffusion was found for any angle in a direction perpendicular to the edge dislocations. The results are discussed in terms of current models of a grain boundary. [See Abstr. 2956 (1948), 7592 (1950)]. A. D. LE CLAIRE

539.217

9013. Corrigenda: Self-diffusion in tin crystals. P. J. FENSHAM. *Aust. J. Sci. Res. A*, **4**, 229–30 (*June*, 1951). See Abstr. 1339 (1951).

539.217

9014. The room temperature solubility of iron in copper. T. S. HUTCHISON AND J. REEKIE. Letter in *Phys. Rev.*, **83**, 857 (*Aug.* 15, 1951).

Precision lattice parameter and density measurements of alloys containing up to 1·4% Fe showed that the max. solubility is ~0·26% by wt.; at higher concentrations the excess Fe is precipitated.

A. D. LE CLAIRE

539.22 : 548.7

9015. On the superlattice formation in binary alloys of body-centred cubic type. S. MATSUDA. *J. Phys. Soc. Japan*, **6**, 131–5 (*May–June*, 1951).

Taking into account both nearest neighbour and second nearest neighbour interactions, a procedure necessary for this type of superlattice, equations are derived the solutions of which give the atomic arrangements in the equilibrium state at a given temperature in terms of the various interaction potentials and the concentration of the alloy. Three types of solution are recognized as corresponding to the FeAl and the Fe_3Al type superlattices and to a random arrangement of atoms. A discussion follows on the influence of the sign and relative magnitude of the second neighbour interaction potential on the type of superlattice that will exist at any given concentration. Experimental observations on Fe–Al alloys [*Proc. Roy. Soc. A*, **136**, 210–32 (*May*, 1932); *Proc. Roy. Soc. A*, **145**, 529–39 (*July*, 1934)] are shown to be consistent with predictions of the theory for a suitable choice of interaction potentials.

A. D. LE CLAIRE

539.234 : 539.27

9016. Structure of thin metallic films formed by evaporation on molybdenite. Y. KAINUMA. *J. Phys. Soc. Japan*, **6**, 135–8 (*May–June*, 1951).

A study by electron diffraction of films of Au, Cu, Ni, Pt, Al and Ag evaporated in vacuum (10^{-4} mm Hg) on to cleavage faces of MoS_2 held at various temperatures up to 500°C. An orientation was found for all metals, except Al due possibly to contamination, with their (111) plane parallel to the cleavage face and the [110] axis of the former parallel to the [100] axis of the latter. By reflection across (100) a second orientation is possible. When both were present in equal amounts the orientation was described as symmetric and when one orientation predominated, as asymmetric. Asymmetric orientations were found for Au and Ni only at $T > 200$°C; for Cu, Ag and Pt at all temperatures only symmetric ones. Although MoS_2 is hexagonal, the layers of atoms and therefore the surface forces have trigonal symmetry so the occurrence of an asymmetric type orientation is reasonable. The occurrence of the symmetric type is thought to be connected with oriented adsorbed surface layers of long chain molecules. A. D. LE CLAIRE

539.26

9017. A simple method of X-ray microscopy and its application to the study of deformed metals. R. W. K. HONEYCOMBE. *J. Inst. Met.*, **1**, 39–44 (*Sept.*, 1951).

A method of obtaining images from metal crystals, using a line source of characteristic X-rays, is described. The images can be enlarged to at least 50 diameters to reveal significant microscopic phenomena, in particular distortions arising from slight plastic deformation which are not readily observed by optical micrography. However, optical micrography is of great assistance in the initial interpretation of the X-ray images, and the two techniques should be regarded as complementary. The scope of the method in the study of plastic deformation is illustrated by a series of X-ray and optical micrographs obtained from metal crystals deformed under varying conditions. A.

539.26

9018. Modulated structures in some copper-nickel-iron alloys. M. E. HARGREAVES. *Acta Cryst.*, **4**, 301–9 (*July*, 1951).

539.26

9019. X-ray detection of long-range order in Ni_3Mn. B. L. AVERBACH. Letter in *J. Appl. Phys.*, **22**, 1088–9 (*Aug.*, 1951).

By a suitable choice of monochromator undesirable reflections occurring at the same Bragg angle as the superlattice lines are avoided and the existence is demonstrated of a Cu_3Au type superstructure, with lattice parameter 3·59 Å. A. D. LE CLAIRE

539.26, 539.215.4

9020. Design of and measurements with a simple double crystal spectrometer for small angle scattering. H. DAAMS AND J. J. ARLMAN. *Appl. Sci. Res.*, **B2** (*No.* 3) 217–26 (1951).

A simple double crystal spectrometer is described for measuring the scattering of X-rays below 0·1 rad. A polystyrene latex of extremely uniform particle size was dried. The X-ray diagram of this specimen indicates a highly regular arrangement of the spheres. The particle size of 225 Å is determined for a sample of magnesium oxide by the method of Shull and Roess [Abstr. 1877–8 (1947)] in good agreement with the value found by electron microscopy, while carbon black particles of 1 000 and 3 000 Å gave scattering curves corresponding with much smaller sizes. A.

539.27

9021. An electron microscope and diffraction study of metallic smoke. R. TAKAGI. Note in *J. Phys. Soc Japan*, **6**, 204 (*May–June*, 1951).

539.27

9022. The preparation of tissue sections for examination in the electron microscope. K. Beyersdorfer and E. Mölbert. *Optik*, **8**, 278–83 (*June*, 1951) *In German.*

Describes a sectioning technique in which a hand microtome is used, the specimen being placed in an embedding medium made of various waxes. This medium is extracted by benzene in a special specimen holder which preserves the flatness of the section, the section then being fixed by exposure for 2–2½ hr to a weak glow discharge at a pressure of about 0·05 mm Hg. Such a fixation process prevents the section from shrinking or tearing while under examination in the electron microscope. Examples are given of the application of the technique to mammary and rectal carcinomas. J. THEWLIS

539.27 : 539.133

9023. The molecular structures of the acetyl halides. P. W. Allen and L. E. Sutton. *Trans Faraday Soc.*, **47**, 236–54 (*March*, 1951).

The molecular structures of the acetyl halides have been determined by the method of electron diffraction in the vapour phase. The carbon-halogen distances are (with the exception of acetyl fluoride) longer than in the methyl halides, the percentage lengthening increasing in the order chloride, bromide, iodide. The carbonyl bond lengths are slightly shorter than in acetone and acetaldehyde. The results for the carbon-halogen bond lengths are correlated with available data on bond dissociation energies and calculated bond energies and are shown to give smooth length against strength relationships. Possible causes of the bond lengthening are discussed. A.

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.31

9024. On the decomposition of any state of equilibrium into two simple states derivable from holomorphic functions. F. Teissier du Cros. *C.R. Acad. Sci., Paris*, **233**, 223–5 (*July* 16, 1951) *In French.*

Some theorems on the superposition and decomposition of plane elastic stress distributions are proved, and a result useful for photoelastic techniques is derived. A. T. PRICE

539.32

9025. The variation of the Young's modulus of a ferrite [of Ni and Zn] with density. L. Weil. *Ann. Inst. Fourier*, **2**, 207–13 (1950) *In French.*

Resonance measurements using magnetostriction on annular test pieces of varying dimensions and densities suggest that the Young's modulus increases linearly, and rapidly, with increasing density.

A. J. KENNEDY

539.32

9026. Elasticity of soft polymers. C. A. Dahlquist, J. O. Hendricks and N. W. Taylor. *Industr. Engng Chem.*, **43**, 1404–10 (*June*, 1951).

In order to measure precisely the elastic properties of polymers and plasticized rubber compounds which are too soft to test on conventional stress-strain machines, a constant-stress method of elongation was developed. Constant stress is achieved by employing a tension weight in the shape of a hyperboloid. As the film stretches, the weight is lowered into a liquid, and buoyancy reduces the load in proportion to the decrease in cross-sectional area of the test specimen. The variation in modulus with time is determined. This is of importance in the measurement of the elastic properties of soft polymers because their elastic behaviour is highly time-dependent. The method has been particularly useful for characterizing unvulcanized polymers and for evaluating plasticizers in uncured compounds. A.

539.32 : 534.321.9 : 541.182.5

Ultrasonic studies of Weimarn gels. *See Abstr.* 9080

539.32 : 548.73

Determination of elastic constants of crystals from diffuse reflexions of X-rays. *See Abstr.* 9131–2

539.374

9027. The flow properties of elastic dispersions. W. J. Dunning and D. Patterson. *Rep. Brit. Elect. Res. Ass., Ref. L/T217*, 11 *pp.* (1949).

The purpose of the present investigation was to prepare systems from a Newtonian liquid and from an elastomer which approximated to the model used in the theory developed by Fröhlich and Sack. The flow properties of such prepared systems have been studied and the results analysed with a view to checking the theory. [See Abstr. 3365 (1951)]. A.

539.374

9028. The plastic-elastic behaviour of matter. (Dispersion of the modulus of elasticity with periodic deformation). F. H. Müller. *Z. Elektrochem. angew. phys. Chem.*, **54**, 204 (1950).

A historical survey leads up to W. Kuhn's explanation of the relationship between the modulus of rigidity at infinitely fast deformation, the time of relaxation and the viscosity constant. With most materials not only one bond mechanism with a specific modulus of elasticity, and only one time of relaxation is effective, but a whole series of bond mechanisms are necessary for the description of the mechanical behaviour. To measure all these effects the "relaxation spectrum" is used, where the distribution of the mechanisms in relation to the relaxation time is shown. The methods described in British and American literature are similar to the author's method, which is analogous to that used for dielectric dispersion, and for that reason is called elastic dispersion. The experiments will be continued to show the connection between the deformation properties and chemical structure, and their parallel dielectric behaviour. British Rheologists' Club

539.374

9029. Effect of strain rate on the plastic deformation in aluminium single crystals. H. Nishimura and J. Takamura. *Mem. Fac. Engng Kyoto Univ.*, **13**, 1–20 (*Jan.*, 1951).

A study, by electron microscope and X-ray methods, of the fine structure of the slip bands in 99·9% pure electrolytically polished specimens for loading rates between 0·0126 and 56·9 g/mm²/sec and total strain of around 5%. Specimens subjected to a slow rate

of strain generally showed (1) wider slip bands; (2) wider spacings between slip bands; (3) fewer sets of active glide planes and (4) more pronounced X-ray asterisms than did specimens subjected to a fast strain rate. The slope of the slip band itself relative to the specimen surface decreased with an increase in the width of the slip band. Only for the higher rates of strain was the slip band composed of many narrow glide lamellae. For all strain rates submicroscopic fine slip lines were observed between the normal slip bands. Slip bands were readily produced at a fine notch line scratched, before straining, on the surface of a specimen perpendicular to the bands, but were absent near to a similar line scratched along the direction of the bands. An oblique line had no marked effect on the slip band behaviour.

A. D. LE CLAIRE

539.374 : 548.0

9030. The development of deformation textures in metals. II. Body-centred cubic metals. E. A. CALNAN AND C. J. B. CLEWS. *Phil. Mag.*, **42,** 616–35 (*June*, 1951).

For Pt I, see Abstr. 1373 (1951). An attempt to explain deformation textures from the behaviour of single crystals, based on the concepts set out in Pt I. Newly calculated maximum resolved shear stress diagrams are reproduced for (*a*) the $\{110\}\langle 111\rangle$ and $\{111\}\langle 110\rangle$; (*b*) the $\{112\}\langle 111\rangle$; and (*c*) the $\{123\}\langle 111\rangle$ systems; and the most favourable slip systems in each case are tabulated. Tension and compression textures are derived for the cases of independent operation with equal (and also for unequal) critical shear stresses. Rolling and drawing textures follow similarly from the treatment in Pt I. Agreement with observed results is good, but the rolling textures of Fe alloys require the further assumption that in adjacent regions of the same grain there are differences in the critical shear stress ratios. This leads to an explanation of the wavy slip lines in α-iron. A. J. KENNEDY

539.4.016

9031. Work-hardening of mild steel by explosive attack. J. S. RINEHART. Letter in *J. Appl. Phys.*, **22,** 1086–7 (*Aug.*, 1951).

A thin layer of explosive was detonated on the surface of mild steel plates 2–3 in thick, and the Rockwell hardness H measured at various distances d below the exposed surface. H decreases rapidly with increasing d, then remains constant for a considerable distance and finally decreases gradually to the original H of the plate. The effects of varying the amounts of explosive and the initial plate H are described and the results are briefly discussed.

A. D. LE CLAIRE

539.431

9032. The problem of the mechanism of the fatigue failure of steel. N. V. TYZHNOVA. *J. Tech. Phys., USSR*, **21,** 187–95 (*Feb.*, 1951) *In Russian.*

539.434

9033. Creep and stress rupture as rate processes. I. S. SERVI AND N. J. GRANT. *J. Inst. Met.*, **1,** 33–7 (*Sept.*, 1951).

Creep data for an Fe–Co–Cr–Ni alloy reported by Grant and Bucklin [*Trans Amer. Soc. Metals*, **42,** 720 (1950)] are analysed according to the rate-process theory of plastic flow. The data indicate that the theory can be applied over only a limited range of creep rates. An empirical equation, which relates the applied stress and the temperature to the minimum creep rate, is suggested for the analysis of creep data. This equation is valid only in the absence of structural instabilities. A.

539.501

9034. Equations of motion of an incompressible elasto-viscous medium. E. V. KUVSHINSKIĬ. *J. Exp. Theor. Phys., USSR*, **21,** 88–92 (*Jan.*, 1951) *In Russian.*

On the basis of two equations expressing the rheological laws of an incompressible elasto-viscous medium (Reyner—Ten lectures on theoretical rheology) derived according to Maxwell's hypothesis, equations are derived for the motion of such a medium. An analysis is made of cases where these equations can be simplified. The analysis shows that for small stresses, where only the linear rheological law applies, the elasticity of the medium manifests its characteristic form only for unsteady processes. In the case of steady flow, with certain reservations, the elasto-viscous medium is displaced according to the laws of the hydrodynamics of viscous liquids. W. HUGHES

539.501

9035. Secondary stresses in viscoelastic flow. M. MOONEY. *J. Coll. Sci.*, **6,** 96–107 (*April*, 1951).

Theoretical equations are developed for secondary stresses in a shearing viscoelastic fluid. The theory assumes that the elastic stresses developed by the continuous shear also relax continuously in accordance with Maxwell's relaxation theory of viscosity. The steady-state strains are analysed by the theory of superelasticity. The final equations predict pressure effects to be expected in rotating viscometers of cylindrical, plate and conical form. In the absence of thixotropy in the test liquid, the secondary stresses are quadratic in the angular velocity. Thixotropy leads to more complicated equations and permits agreement with more complex experimental results. A.

539.62

9036. Metallic transfer between sliding metals: an autoradiographic study. E. RABINOWICZ AND D. TABOR. *Proc. Roy. Soc. A*, **208,** 455–75 (*Sept.* 24, 1951).

Describes a study of the friction and metallic transfer between sliding metal surfaces in the absence and in the presence of boundary lubricant films. One surface is made radioactive and is slid over the surface of a second, non-radioactive metal, the amount of metal transferred being detected by the blackening of a photographic plate placed in contact with the second surface. The results show that, in general, the metallic transfer or "pick-up" consists of a relatively small number of discrete particles. As the temperature is raised a marked increase in friction and "pick-up" occurs at a temperature close to the melting-point of the film. A new observation is that at a somewhat higher temperature a further deterioration in lubricating properties occurs. These changes are reversible on cooling, and it is suggested that they correspond to

changes in state of the lubricant film. The results provide direct support for the view that the friction between metals is due largely to the formation and shearing of metallic junctions, and that the main function of a boundary lubricant is to reduce the amount of metallic interaction. The investigation also shows that the metallic transfer is immensely more sensitive to changes in surface conditions than is the coefficient of friction. A.

539.62

9037. Comments on several friction phenomena. G. P. BREWINGTON. *Amer. J. Phys.*, **19**, 357–8 (*Sept.*, 1951).

It is suggested that the term dry friction be limited to phenomena observed under highly outgassed conditions. Two theorems are suggested, one on the distribution of heat energy between two friction surfaces and the other on the independence of the heat loss in certain clutches, on the coefficient of friction. Several suggestions using concepts of the physics of the solid state are made to give a better picture of the ultimate cause of friction. A.

539.62 : 539.23

9038. Friction of diamond, graphite, and carbon and the influence of surface films. F. P. BOWDEN AND J. E. YOUNG. *Proc. Roy. Soc. A*, **208**, 444–55 (*Sept.* 24. 1951).

The removal, by outgassing *in vacuo*, of surface films which are normally present causes a large increase in the friction. The admission of a small amount of O, water vapour or other contaminant will reduce the friction. Both physical adsorption and chemical adsorption are important. There is evidence that with clean graphite surfaces there is strong adhesion at the interface, so that when sliding takes place slip and shearing occurs beneath the surface. Carbon and graphite have a negative temperature coefficient of friction. The low friction normally observed with diamond is due to the presence of adsorbed O and other gases. The friction of clean diamond on diamond is high, and the shear strength at the interface is comparable with the shear strength of diamond. Large-scale seizure does not occur because the deformation of the diamond in the region of contact is elastic and the real area of contact necessarily remains small. A

539.621 : 539.21

9039. Rupture of oxide films during repeated sliding. A. J. W. MOORE AND W. J. MCG. TEGART. *Aust. J. Sci. Res. A*, **4**, 181–4 (*June*, 1951).

When Cu specimens are subjected to repeated sliding, non-metallic particles are included below the surface. They are derived from the rupture of oxide films during sliding. On annealing at temperatures near the melting-point of Cu, the particles coalesce but prevent grain growth of the Cu. The relation of these facts to the layers formed by polishing is discussed briefly. A

539.6

9040. Internal friction of cold worked single crystals of copper. R. R. HASIGUTI AND T. HIRAI. Letter in *J. Appl. Phys.*, **22**, 1084–5 (*Aug.*, 1951).

The internal friction Q^{-1} increases rapidly to a maximum with increase in cold work and then decreases to a fairly constant level a little above the original value. Comparison of these measurements with the stress-strain curve shows that Q^{-1} begins to decrease from its max. value when the rate of hardening begins to increase. The results are discussed in terms of dislocation theory. A. D. LE CLAIR

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.5

9041. The mechanism of exchange between radioactive ions in solution and metal surfaces. M. T. SIMNAD AND R. C. RUDER. *J. Electrochem. Soc.*, **98**, 301–6 (*Aug.*, 1951).

The mechanism of exchange between metals and ions in solution has been studied with radioactive Co ions in solutions into which various metals with different surface treatments were immersed in the presence and absence of O. The metals were washed after various times of immersion in the solutions, their acquired radioactivities measured, and the distribution of radioactive Co on the surfaces shown by means of autoradiographs. The results indicate that local cell action, due to differences of potential on the metal surfaces, is the factor which governs the radioactivity acquired by the metals. By applying Faraday's law, it has been possible to calculate the magnitudes of local cell currents on the metal surfaces from the acquired activities. A.

541.123.

9042. Isotopic exchange between metal ions of different valency. J. WEISS. Letter in *J. Chem. Phys.* **19**, 1066–7 (*Aug.*, 1951).

The mechanisms of isotope exchange reactions are discussed from the standpoint of the operation of reversible oxidation-reduction processes, which will depend for any particular mechanism on the redox potentials of the system under consideration. Some possible exchange mechanisms are indicated for the following ionic systems: Cr^{2+}/Cr^{3+}, Ti^{2+}/Ti^{3+}, V^{2+}/V^{3+}, Cu^{+}/Cu^{2+}, $FeCy_6^{4-}/FeCy_6^{3-}$, Fe^{2+}/Fe^{3+}, Mn^{2+}/Mn^{3+}, Ce^{3+}/Ce^{4+}, and Co^{2+}/Co^{3+}, in aqueous solutions in the presence and in the absence of O_2.

H. H. HODGSO

541.123.59 : 541.12

9043. Kinetics of isotopic exchange reactions. G. M. HARRIS. *Trans Faraday Soc.*, **47**, 716–21 (*July* 1951).

The rate characteristics of isotopic exchange reactions are analysed in general terms. A discussion is given of the influence of appreciable isotope effect on the kinetics. The nature of the errors involved in the neglect of this factor is considered.

541.124

9044. A periodic chemical reaction. The reaction between hydrogen peroxide and iodic acid. M. G. PEARD AND C. F. CULLIS. *Trans Faraday Soc.*, **47**, 616–30 (*June*, 1951).

In the reaction between HIO_3 and H_2O_2, the rate of evolution of O may, in certain circumstances, vary periodically with time. Factors affecting the periodicity have been examined, and the mechanism of the reaction is discussed. It is suggested that the periodicity is the result of the interplay of two factors, the autocatalytic nature of the reaction, and the physical removal of the product responsible for the catalysis by the other product, O. A.

541.124

9045. Low temperature oxidation of copper. II. Reaction rate anisotropy. T. N. RHODIN, JR. *J. Amer. Chem. Soc.*, **73**, 3143–6 (*July*, 1951).

For Pt I, see Abstr. 3073 (1951). The oxidation rate of single crystal copper surfaces exposed to pure oxygen at low temperatures from 78 to 323°K has been observed to be highest for the least densely packed (100) face and smallest for the most densely packed (111) face. The rate anisotropy is adequately described by the mathematical treatment of Mott and Cabrera although the physical significance of their assumptions is ambiguous. The reaction rate anisotropy was also shown to be consistent with the theoretical requirements of Frank and Van der Merwe for the existence of oriented overgrowths. According to their model, pseudomorphic oxide structures may account for the oxidation rate anisotropy. A.

541.124

9046. Oxidation-reduction reactions of neptunium (IV) and -(V). J. R. HUIZENGA AND L. B. MAGNUSSON. *J. Amer. Chem. Soc.*, **73**, 3202–6 (*July*, 1951).

The rate law for the reaction $Np(IV) + Fe(III) \rightleftarrows Np(V) + Fe(II)$ may be expressed as $d[Np(IV)]/dt = k_2[Np(V)]\ [Fe(II)][H^+] - k_1[Np(IV)]\ [Fe(III)]/[H^+]^3$. The reactions involve a hydrolytic mechanism. The forward rate constant, k_1, is $3{\cdot}4$ moles^2 litres^{-2} min^{-1} and the reverse rate constant, k_2, is $4{\cdot}7$ moles^{-2} litres^2 min^{-1} at 25° in $1{\cdot}0$M perchlorate solutions. The apparent activation energy of the forward reaction is 35 kcal mole^{-1}. The forward rate constant is smaller in nitrate solutions as would be expected from spectral evidence for nitrate complexing of Np(IV). A.

541.124 : 535.343.4–14 : 545.82

9047. Microwave spectroscopic investigation of the kinetics of the heterogeneous ammonia-deuterium exchange. J. WEBER AND K. J. LAIDLER. *J. Chem. Phys.*, **19**, 1089–96 (*Sept.*, 1951).

A method is described for analysing a mixture of gases using microwave spectroscopy. Relatively simple microwave measurements are employed on single resolved collision-broadened spectral lines. For binary mixtures, only the peak absorption coefficients need to be measured if the microwave collision diameters are known. Mixtures of isotopically substituted molecules can also be analysed because the microwave absorption lines of the isotopic species are easily resolved. The technique is applied to determining the mole fraction of NH_3 in mixtures of deuterated ammonias, and to a study of the kinetics of the NH_3–D_2 isotopic exchange reaction on a singly promoted Fe catalyst. It is found that rates of desorption of molecules from surfaces are markedly increased on adsorption of other molecules, a fact that can be explained only in terms of strong interactions between adsorbed molecules. The rate of the exchange reaction is proportional to the square root of the D_2 pressure. With increasing NH_3 pressure the rate passes through a maximum, showing that the mechanism involves reaction between adsorbed NH_3 and adsorbed D atoms. The activation energy diminishes significantly with increasing NH_3 pressure, providing additional evidence for the existence of strong interactions between adsorbed molecules. A.

541.124 : 539.155.2

9048. Isotope effect in the oxidation of carboxyl-C^{14} acetic acid. E. A. EVANS AND J. L. HUSTON. Letter in *J. Chem. Phys.*, **19**, 1214 (*Sept.*, 1951).

541.126 : 534.222.2 : 536.46

9049. Gaseous detonation. I. Initiation of detonation. A. J. MOORADIAN AND W. E. GORDON. *J. Chem. Phys.*, **19**, 1166–72 (*Sept.*, 1951).

By means of piezoelectric gauges, a study has been made of the development of detonation from a shock wave propagated into a mixture. With a sufficiently strong shock, detonation above the stable velocity is immediately established which decays smoothly to the steady state. When the shock is weaker than required for detonation the phenomena which ensue depend upon the strength of the shock wave and the nature of the medium. A zone of combustion, accompanied by a build-up of the pressure, develops in the wake of the shock front. This may lead to a smooth acceleration of the latter until detonation is established; shock waves may be formed which overtake the front and cause detonation; or the initial shock may decay without detonation. The hydrodynamic properties of the medium are particularly important in determining the sequence of events. Composition and pressure limits are observed beyond which detonation cannot be initiated in any case. Near these limits there is always "spin" in the detonation, which appears on the pressure records as a periodic oscillation of the pressure for some distance behind the wave front. In these experiments the initiating shock wave was produced by a detonating mixture such as $2H_2$–O_2 contained behind a cellophane diaphragm. The strength of the shock wave was very much increased when this mixture was diluted with H_2. A.

541.127

9050. The kinetics of combination of carbon dioxide with water and hydroxide ions. B. R. W. PINSENT AND F. J. W. ROUGHTON. *Trans Faraday Soc.*, **47**, 263–9 (*March*, 1951).

The velocity constant of the reaction $CO_2 + H_2O \rightarrow H_2CO_3$, has been determined over the range 0° to 38°c by measuring manometrically the rate of uptake of CO_2 by phosphate and veronal buffer solutions. Only small corrections were necessary for the limiting effect of diffusion between the gaseous and liquid phases. The velocity of the reaction $CO_2 + OH^- \rightarrow HCO_3^-$ has also been determined in the *p*H range $10{\cdot}2$–$9{\cdot}9$ by manometric measurement of the rate of

CO_2 uptake of carbonate bicarbonate buffer solutions. Only at 0°c were reasonably satisfactory corrections for diffusion possible. By plotting an appropriate function of the velocity of the reaction against ionic strength, the value of the velocity constant of the reaction $CO_2 + OH^- \rightarrow HCO_3^-$ at zero ionic strength is obtained by extrapolation. The values at 0°c, viz. 1 050, agrees within ± 15% with the less fully corrected values of previous observers. A.

541.127

9051. The kinetics of the thermal decomposition of acetic anhydride. M. Szwarc and J. Murawski. *Trans Faraday Soc.*, **47**, 269–74 (*March*, 1951).

The decomposition of acetic anhydride is shown to be a truly unimolecular dissociation process in which $(CH_3CO)_2O \rightarrow CH_2 : CO + \dot{C}H_3 . COOH$. This decomposition does not involve radicals, the unimolecular rate constant being given as $k = 1 \times 10^{12} \exp(-34\,500/RT)\,sec^{-1}$. This type of decomposition is favoured by the geometry of acetic anhydride molecule. A.

541.127

9052. An apparatus for measuring the rates of some rapid reactions. C. D. McKinney, Jr and M. Kilpatrick. *Rev. Sci. Instrum.*, **22**, 590–7 (*Aug.*, 1951).

As a means of studying the kinetics of rapid reactions in which a gas is evolved, a constant volume reactor has been designed. This reactor employs a static technique in which the reaction is followed by the increase in pressure as the gas is evolved. The apparatus is capable of mixing 1 ml of one reactant with 25 ml of a second reactant in < 10 msec. The pressure-sensitive device is a strain gauge, the output of which is plotted as a function of time by a cathode-ray oscilloscope. The apparatus was tested for complete mixing and desaturation of the gas from the liquid phase by means of a reaction known to be very fast: the homogeneous reaction between the permanganate ion and hydrogen peroxide in acid solution. The reaction between Li borohydride and sulphuric acid was found to have a half-time of approximately 1 sec. The half-time of the reaction between Na–K alloy and ethanol was only a few msec. The reactions of Al borohydride and ethylaluminum sesquihydride with water and with acids were also studied. A.

541.127 : 535.33.072

9053. Rapid and sensitive spectrophotometry. I. The accelerated and stopped-flow methods for the measurement of the reaction kinetics and spectra of unstable compounds in the visible region of the spectrum. B. Chance. *Rev. Sci. Instrum.*, **22**, 619–27 (*Aug.*, 1951).

The present form of the methods for measurement in biochemical reactions is described. This apparatus gives satisfactory records with only a few tenths of a cm^3 of 2×10^{-7} M Fe enzyme solution and covers a time range from a few msec to several minutes. Wavelength range 370 to 600 mμ; spectral interval, 7·5 mμ. The error in optical density measurement is about 1×10^{-5} corresponding to a signal-to-noise ratio of 5×10^4 for a response time of 1 sec over the wavelength range of 380–580 mμ. A.

541.127 : 535.33.07

9054. Rapid and sensitive spectrophotometry. II. A stopped flow attachment for a stabilized quartz spectrophotometer. B. Chance and V. Legallais. *Rev. Sci. Instrum.*, **22**, 627–34 (*Aug.*, 1951).

The stabilization of the light sources and the photocell circuits of a quartz spectrophotometer and the design of suitable stopped flow apparatuses are described. The latter have been designed for 1·6- and 10-mm optical paths and have been shown to give rapid mixing (< 0·1 sec). Errors of optical density measurement are diminished by rectangular observation tubes, and errors of extinction coefficients are minimized by a narrow spectral interval (< 2 mμ from 230–600 mμ). The error of optical density caused by the photoelectric circuits is about $1 \times 10^{-}$ for a response time (10–90%) of 1 sec. The application of this apparatus to the measurement of rapid chemical reactions in the visible and ultraviolet regions is described. A.

541.127 : 535.33.07

9055. Rapid and sensitive spectrophotometry. III. A double beam apparatus. B. Chance. *Rev. Sci. Instrum.*, **22**, 634–8 (*Aug.*, 1951).

An apparatus for accurately timing the sequence of spectroscopic events in turbid suspensions of the cytochrome oxidase system has been developed. This apparatus measures simultaneously small optical density changes occurring at two wavelengths in the visible region with a small spectral interval in spite of the large scattering of light by the heart muscle suspensions. The cross-talk between the two channels corresponds to an optical density change of $< 5 \times 10^{-4}$. Transients arising from the modulation and demodulation processes cause no difficulty. The error of optical measurements caused by the noise level in the photocurrent is 2×10^{-4} for a rise time (10–90%) of 1 sec. Some typical experimental results are included. A.

541.127 : 539.23

9056. Kinetics of the formation of oxide films on zinc foil. W. J. Moore and J. K. Lee. *Trans. Faraday Soc.*, **47**, 501–8 (*May*, 1951).

The oxidation kinetics of Zn foil have been studied over a range of temperatures from 300° to 400°c, and of pressures from 1·0 to 40·0 cm Hg. Below 350° the rate follows a logarithmic equation, $dy/dt = ae^{-by}$ where y is the oxide-film thickness. Above 370° the rate follows a parabolic equation, $dy/dt = k/y$. The parabolic rate constant is markedly pressure dependent, following an expression $k = k_0 bP/(1 + bP)$. This behaviour can be interpreted in terms of an activated adsorption of O at the ZnO surface. The activation energy of k_0 is 28·5 kcal/mole, and $b = b_0 \exp[-42{\cdot}2\ (kcal)/RT]$. A.

541.127 : 541.1

9057. Determination of absolute rate constants for olefinic oxidations by measurement of photochemical pre- and after-effects. II. At "low" oxygen pressures. L. Bateman, J. L. Bolland and G. Gee. *Trans. Faraday Soc.*, **47**, 274–85 (*March*, 1951).

For Pt I, see Abstr. 4853 (1951). The aim was to supplement the results given in Pt I by determining

the absolute rate constants of the reactions R— + $O_2 \rightarrow$ and 2R— $\rightarrow$ (k_2 and k_4, respectively). However, the application of the technique therein described to oxidations at low O pressure is seriously impeded by the rate control exerted by O diffusion. Termination reactions involving RO_2— radicals only become negligible at pressures so low that, under our experimental conditions, diffusion is completely rate controlling. Approximate values of the ratio $k_2k_4^{-1}$ have been determined for ethyl linoleate and digeranyl, and these, taken in conjunction with the more accurately determinable $k_2k_4^{-\frac{1}{2}}$ values (data for 9 olefins being reported), permit approximate evaluation of the separate rate constants. The significance of the results is discussed, particularly in relation to other comparable radical reactions. A.

541.128

9058. The parahydrogen conversion on tungsten. G. D. HALSEY, JR. *Trans Faraday Soc.*, **47**, 649–56 (*June*, 1951).

The assembled data on the parahydrogen conversion on clean W surfaces are considered from the standpoint of the heterogeneous surface. The isotherm data of Eley and Rideal are analysed and the Bonhoeffer–Farkas and various Rideal mechanisms are considered. The mechanism finally adopted is that of exchange between chemisorbed H and molecular H adsorbed on van der Waals' sites of varying energy. These sites are located between two bare chemisorption sites. An activation energy of adsorption of several kilocalories is necessary for the success of any of these mechanisms. A.

ELECTROCHEMISTRY 541.13

541.133

9059. The conductivity of aqueous solutions of a 6 : 1 valency type electrolyte. J. C. JAMES. *Trans Faraday Soc.*, **47**, 392–5 (*April*, 1951).

The conductivities at 25°C of aqueous solutions of a 6 : 1 valency type electrolyte, *tris*-triethylene tetramine cobaltic chloride, are reported, and the nature of the conductivity curve is discussed. The conductivities of mixed solutions, containing this salt and other electrolytes of various valency types, have been studied, and it is concluded that extensive ion association occurs between the hexavalent cations and bivalent anions. A.

541.133

9060. An empirical extension of Onsager's conductivity equation. P. A. H. WYATT. *Trans Faraday Soc.*, **47**, 656–9 (*June*, 1951).

The equation $\Lambda = \Lambda_0 - \{(A\Lambda_0 + Bd)/d^{3/2}\}c^{1/2}$, where $d = 1 + ac^{2/3}$, represents the data for completely dissociated electrolytes with accuracy up to 0·1N. The empirical constant a has a characteristic value for each electrolyte but depends mainly on valency type; and the approximation $a = 1{\cdot}3(z_1 + z_2)$ is sufficiently accurate for the application of the formula to cases of incomplete dissociation. For unsymmetrical electrolytes the form $d = 1 + 3{\cdot}3\,I^{2/3}$ is recommended. A.

541.135

9061. Anodic polishing of nickel in electrolytes containing chlorine ions. S. TAJIMA AND T. MORI. *C.R. Acad. Sci., Paris*, **233**, 160–2 (*July* 9, 1951) *In French.*

The anodic behaviour of Ni in solutions of HCl, NH_4Cl, $AlCl_3$ and $MgCl_2$ is described. At all concentrations from 1 g mol. to saturation, the current-voltage curve has the typical form for that observed in polishing processes, and the surfaces obtained are passive. The effect of rise of temperature is the inverse of that in H_2SO_4, e.g. polishing becomes more difficult. In solutions of NaCl, $CdCl_2$ and $ZnCl_2$, all become alkaline during electrolysis, and only $CdCl_2$ admits of polishing. Additions to the bath, such as glycerine and certain sulphurated higher alcohols, enlarge the domain of polishing. H. H. HODGSON

541.135 : 541.182

9062. An interionic attraction theory applied to the diffuse layer around colloid particles. I. A. L. LOEB. *J. Coll. Sci.*, **6**, 75–91 (*Feb.*, 1951).

Interionic forces in dilute electrolytic solutions have been successfully treated by Debye and Hückel, but their theory is not directly applicable to regions of solutions near plane surfaces, especially when these surfaces are highly charged, as in the case of lyophobic colloid particles treated by Langmuir. It is shown that even when the total potential is high, that part dependent on an ion being at any given location still obeys approximately a linear differential equation. The concentration distribution and forces between the particles are derived, and compared with the results that Langmuir obtained neglecting interionic forces. The extended interionic attraction theory is applied to uncharged or slightly charged surfaces in equilibrium with electrolytic solution. A.

541.135.2

9063. Theory of systems of electrically charged particles. A. E. GLAUBERMAN. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 5) 883–5 (1951) *In Russian.*

The results of Bogolyubov's statistical method (1946) of treating systems of Coulomb particles in equilibrium, by which a binary distribution function is obtained as a first approximation, but further approximations are impossible owing to increasing divergence of the expansion, is criticized as a case of inadmissible physical extrapolation of the law of interaction to small distances, where Coulomb's law does not apply. The author therefore tries to apply Bogolyubov's method to a second approximation by a "smoothed" potential. Physically this is equivalent to introducing certain repulsion forces, which is appropriate for applications to electrolyte solutions. The potential introduced is of the form $\Phi_{ab}(r) = e_a e_b/\varepsilon r[1 - \exp(-\alpha r)]$ where ε is the diel. const. and parameter $\alpha r \gg 1$. It is seen that Bogolyubov's method now yields further approximations reducing to simple expressions which make physical sense and may be applied to calculating the free energy and determining the "activity" of an electrolyte in solution. B. F. KRAUS

541.135.5

9064. Potential of the iron electrode. J. D'Ans and W. Breckheimer. Note in *Naturwissenschaften*, **38** (*No.* 12) 282 (1951) *In German.*

Unpublished experiments on the electrochemical potential of Fe indicate that: (1) the cathodic Fe electrode should be regarded for calculation purposes as an alloy of Fe with atomic H; (2) in $FeCl_2$–HCl solution of $\sim pH_3$, the potential varies with H^+ concentration, though not as sensitively as the reversible H-electrode; (3) at higher *p*H values there is a reversible Fe potential dependent on the concentration of Fe^{++} ions; (4) atomic H diffuses through pure Fe; (5) it follows from (1) that every irregularity in charging the Fe-electrode with H-atoms must lead to deviations from the equilibrium potentials, which are (6) illustrated experimentally; (7) for explanation of overvoltage, addition or subtraction of H-atoms must be done in a special way which is outlined, and (8) requires a revision of the Tafel relationship between c.d. and rise of H-overvoltage. These conceptions are important for the interpretation of Fe-corrosion. H. H. Hodgson

541.135.5

9065. Hydrogen overvoltage, electrical double layer and related problems. G. Sutra. *J. Phys. Radium*, **12**, 673–81 (*June*, 1951) *In French.*

The problems of the H^+ ion in aqueous solution and that of overvoltage are discussed, and a new theory advanced. Ions are first adsorbed at the electrode, and set up a double layer at its contact with the solution. This double layer is shown to be formed of ions separated from each other by water molecules, and this explains: (1) divergencies between authors as to the capacity of the double layer; (2) the maximum capacity of a layer formed of less hydrated negative ions which is more compact. The mechanism which determines the current is then the penetration of the protons into the electrode, and overvoltage is simply necessary to secure this penetration of positive ions into a layer already completed. On this hypothesis, a calculation of the current at zero overvoltage is in numerical accord with experimental data. 36 refs. H. H. Hodgson

541.135.5

9066. Fast electrode reactions. J. G. Barredo. Letter in *J. Chem. Phys.*, **19**, 1065–6 (*Aug.*, 1951).

To explain what occurs at electrode-solution interfaces, the variation of current with time has been recorded over time intervals of the order of 4×10^{-3} to 1×10^{-4} sec, with Pt and Hg electrodes immersed in 0·00488M $KMnO_4$, 0·1N NaOH, and other aqueous solutions. The data are satisfactorily described by $d(N/\Sigma)/dt = (K/K_1)(N/\Sigma)^{\alpha}t^{-\frac{1}{2}}$, where N is the number of potentially reactive particles, Σ is the value of the active surface of the electrode, t is the time, α is the number of particles participating in the elemental reaction at the electrode, and K_1 and K_2 are constants. Deduction of the above equation is based, in part, on the assumption of the formation of a region of film around the electrode. The experimental method now outlined may be employed in determinations of the apparent energies of activation involved in the release of respective isotopes of hydrogen over electrodes, and of conditions affecting separation factors. H. H. Hodgson

541.135.6 : 541.183.5

9067. The dielectric constant of the solution in the diffuse and Helmholtz double layers at a charged interface in aqueous solution. B. E. Conway, J. O'M. Bockris and I. A. Ammar. *Trans Faraday Soc.*, **47**, 756–66 (*July*, 1951).

Values of dielectric constant at various positions in the diffuse layer have been calculated using an ordinary differential equation involving ε as $f(\psi')$. The variations of ψ with χ in the diffuse layer have been compared for constant and variable dielectric constants. Anomalies in Stern's treatment of the double layer are discussed in the light of the calculated results and a method of calculating the relationship between V and ψ_1 from Stern's theory using a variable dielectric constant for the diffuse layer is given. A

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.1

9068. Wall effects in photochemically induced chain reactions. R. M. Noyes. *J. Amer. Chem. Soc.*, **73**, 3039–43 (*July*, 1951).

A mathematical solution has been developed for the situation in which photochemically produced atoms or radicals may combine homogeneously at a rate which is second order in the reactants, and simultaneously may combine heterogeneously on the wall by a first-order mechanism. The treatment suggests that the walls may serve to remove those atoms or radicals located in a shell of thickness $0\cdot9(D^2/Qk)^{1/4}$ where D is the diffusion coefficient, Q is the rate of production of chains and k is the rate constant for homogeneous termination. If the volume of this shell is significant compared to the total volume of the system, the walls may be responsible for terminating an important fraction of the chains which are formed. It appears that even in vessels having diameters of several cm a very large fraction of photochemically produced chains may terminate on the wall unless the absorption of radiation is much greater than 10^{12} quanta/ml sec. and/or the pressure is considerably in excess of atmospheric. The treatment also shows the applicability of kinetic data to determine the probability that an atom or radical striking the wall of the vessel will undergo recombination.

541.

9069. Mechanisms of chain termination in chlorine atom reactions. R. M. Noyes and L. Fowler. *J. Amer. Chem. Soc.*, **73**, 3043–5 (*July*, 1951).

Photochemical gas reactions involving chlorine atoms exhibit simultaneous chain-termination steps which are first and second order in the concentration of atoms. The rate of first-order termination has frequently been assumed to involve an impurity present in the gas phase. We have shown that the data can also be explained by assuming a wa

reaction with a recombination coefficient of about 5×10^{-5}. Experiments at much higher total pressures than have been employed in the past will be necessary to distinguish unequivocally between this interpretation and the homogeneous mechanism involving reaction of chlorine atoms with an impurity present in small equilibrium concentration. A.

541.15

9070. On the Szilard–Chalmers effect with fast neutrons. W. Rieder, H. Müller and E. Broda. *Acta Phys. Austriaca*, **4** (*No.* 4) 457–60 (1951) *In German.*

A determination is made of the relative proportions of slow and fast neutrons emitted by a Ra–Be source used for the measurement of the Szilard–Chalmers effect with fast neutrons, in an attempt to explain differences in the yield with As and Mn. Some support is found for the view that, in the absence of a slowing down medium, only the fast neutrons contribute appreciably towards the activation.

J. THEWLIS

541.15

9071. Theory of radiation chemistry. I. Some effects of variation in ionization density. J. L. Magee. *J. Amer. Chem. Soc.*, **73**, 3270–5 (*July*, 1951).

The ionization density in a homogeneous medium exposed to steady irradiation is a function of space and time. The space-time ionization density pattern depends on both the ionization density of the particles used in the irradiation and also the number of particles incident per unit time and area (i.e. the rate of irradiation). In this paper a simple model is presented which describes the life of a particle track in the steady-state condition and thus also gives a description of the variations in ionization density. The author believes that this model contains the essentials of the actual physical situation, and it has the particular advantage that mathematical treatment can be carried out rigorously. In the model account is taken of the background ionization density which is present when a track is formed; this background ionization density can be higher or lower than that of the track itself depending upon the diffusion rate of the ions and radicals formed, their recombination rate constants and the rate of irradiation. Yields in radiation chemistry depend upon whether the background is high or low; this situation is discussed in terms of the model with application to some problems of radiation chemistry. A.

DISPERSION . COLLOIDS ADSORPTION 541.18

541.18 : 541.135.5

9072. The properties of the electrical double layer. I. Thermodynamics of the double layer on silver iodide and mercury. E. L. Mackor. *Rec. Trav. Chim. Pays-Bas*, **70**, 663–74 (*Aug.*, 1951).

A derivation is given of the thermodynamic formulae for the double layer of AgI and of mercury electrodes. It is shown that there is only a quantitative difference in the treatment of the two systems and so one can use the obvious similarities to get a better understanding of the AgI system. A.

541.18.046

9073. Modern colloidchemical concepts of the phenomenon of coagulation. E. A. Hauser. *J. Phys. Coll. Chem.*, **55**, 605–11 (*April*, 1951).

A brief historical review of the theories pertaining to coagulation is offered. In the light of our present knowledge, the shortcomings of the Helmholtz double layer theory and of the Gouy–Freundlich diffuse double layer theory are discussed. It is pointed out that a definite line of demarcation can no longer be drawn between electrocratic and lyocratic colloids in regard to their stability, and experimental evidence for this concept is offered. Attention is drawn to the importance of the morphology and ion distribution in the surface of colloidal particles and why these ions must act differently than when located under the surface. New concepts of solid double layers caused by dipole formation in the surface layer of colloidal matter are offered and their importance is explained on the basis of recent experimental results. A.

541.182 : 532.5

9074. The viscosity of a concentrated suspension of spherical particles. M. Mooney. *J. Coll. Sci.*, **6**, 162–70 (*April*, 1951).

Einstein's viscosity equation for an infinitely dilute suspension of spheres is extended to apply to a suspension of finite concentration. The argument makes use of a functional equation which must be satisfied if the final viscosity is to be independent of the sequence of stepwise additions of partial volume fractions of the spheres to the suspension. For a monodisperse system the solution of the functional equation is $\eta_r = \exp(2{\cdot}5\phi/1 - k\phi)$, where η_r is the relative viscosity, ϕ the volume fraction of the suspended spheres, and k is a constant, the self-crowding factor, predicted only approximately by the theory. The solution for a polydisperse system involves a variable factor, λ_{ij}, which measures the crowding of spheres of radius r_j by spheres of radius r_i. The variation of λ_{ij} with r_i/r_j is roughly indicated. There is good agreement of the theory with published experimental data. A.

541.182 : 539.501

9075. Some aspects of the rheology and the stability of emulsions and suspensions. E. W. J. Mardles and A. De Waele. *J. Coll. Sci.*, **6**, 42–56 (*Feb.*, 1951).

The rheological behaviour of emulsions and suspensions is considered in relation to the properties of surface films adsorbed on the dispersed particles. With change of composition in mixed liquids or with small additions of high molecular weight substances, important variations in thixotropy, etc., of a dispersion are recorded which are due to changes in the character of the interfacial surface film. Friction increases between the particles, for example, result in larger sedimentation volumes and higher specific viscosity. This aspect of the theory of emulsions and suspensions, especially for the more concentrated systems, outweighs the usual approach of purely

hydrodynamic considerations. It is concluded that future progress in this field depends on results of studies on the properties of thin films of liquid adsorbed on surfaces, including friction measurements at low pressures. A.

541.182.2

9076. Droplet transfer from suspending air to duct walls. L. G. Alexander and C. L. Coldren. *Industr. Engng Chem.*, **43**, 1325–31 (*June*, 1951).

The experiments were performed to elucidate the mechanism and to measure typical rates of deposition, on the walls of a straight duct, of small (average diameter 27 microns) water droplets suspended in a turbulent air stream. From the shapes of the radial profiles of mass velocity of suspended matter, it was deduced that, with respect to at least 30 to 60% by weight (depending on the velocity) of the droplets in the spray used, the major resistance to transfer from the air stream to duct wall resided in a relatively thin layer of gas adjacent to the wall. A mathematical relation based on this hypothesis correlated the data reasonably well in terms of an equivalent-film coefficient of mass transfer. The coefficient varied with the 1·17 power of the velocity, and was 10 to 20 times greater, on a mass basis, than coefficients estimated for NH_3 and CO_2 under comparable conditions. A.

541.182.2

9077. Electronic spray analyzer for electrically conducting particles. J. M. Geist, J. L. York and G. G. Brown. *Industr. Engng Chem.*, **43**, 1371–7 (*June*, 1951).

Analyses of sprays and other suspensions frequently involve sampling with microscope, slides, cells, or other relatively large devices, followed by tedious counting procedures. This paper presents some calculations to emphasize the advantage of small samplers and describes preliminary work in the development of an electronic analyser which utilizes a small sampler to measure and to count the particles. Metal spheres, with diameters from 500 to 6 340 microns, and drops of water, alcohol and acetone, with diameters from 2 500 to 4 500 microns, provide data to show that the electrical pulses created upon interception of the particles by the probe wire are proportional to the 1·6 power of the particle diameter. The effects of probe geometry and potential are shown, and the underlying mechanism is discussed. With further development of the geometry of the probe, the electronic spray analyser may offer an extremely rapid method for determining the drop size and size distribution in the spray of an operating nozzle, with a minimum sampling error. A.

541.182.2 : 532.525

Droplet size distribution in sprays. *See Abstr.* 8551

541.182.2 : 532.6

Shatter of drops in streams of air. *See Abstr.* 8556

541.182.2/.3

9078. Preparation of solid- and liquid-in-air suspensions. For use in air pollution studies. R. D. Cadle and P. L. Magill. *Industr. Engng Chem.*, **43**, 1331–5 (*June*, 1951).

541.182.2/.3 : 519.2

9079. Fitting bimodal particle size distributio curves. J. M. Dallavalle, C. Orr, Jr, and H. C Blocker. *Industr. Engng Chem.*, **43**, 1377–80 (*Jun* 1951).

Methods for describing two bimodal distributio curves which occurred in studies of aerosol aggrega tion phenomena are presented. A selected-ordina method is developed and is shown to describe thes bimodal distributions better than the more compl cated methods of moments and least squares.

541.182.5 : 539.32 : 534.321

9080. Ultrasonic studies of Weimarn gels. A. M Srivastava. *J. Acoust. Soc. Amer.*, **23**, 553– (*Sept.*, 1951).

This paper reports measurements of the elasticitie of various Weimarn gels by the use of an ultrason pulse reflection method. Considerations of porosit and composite density of the gel lead, theoretically to an expression for the bulk modulus which agree remarkably well with the experimental value Furthermore, the aging of the gel samples giv ground for concluding that the formation of a g resembles the separation of a solid phase from supersaturated solution. The variation of the elast moduli with temperature has been explained by th postulated structure of these gelatinous substances.

541.182

9081. Theory of anisotropic colloidal solution A. Isihara. *J. Chem. Phys.*, **19**, 1142–7 (*Sept.*, 195

The appearance of anisotropic phase in the unipol coacervations of tobacco mosaic virus or bentoni solutions are explained theoretically, and the recen theory of Onsager is confirmed. As has bee emphasized already by Langmuir, the repulsive forc between solute molecules and the force arising fro thermal agitation are decisive for the occurrence the anisotropic phase. The critical concentratio where the anisotropic phase starts are explicit determined for prolate and oblate spheroidal and al cylindrical solute molecules. It is found that t critical concentrations are all inversely proportion to the axial ratios, and therefore it is explained w these critical concentrations are of the same order magnitude in spite of the totally different characters solute molecules.

541.1

9082. Rate of adsorption on a non-uniform surfa G. D. Halsey, Jr, *J. Phys. Coll. Chem.*, **55**, 21– (*Jan.*, 1951).

Theoretical. The data of Taylor and Liang *Amer. Chem. Soc.*, **69**, 1306 (1947)] for the adsorpti of H on ZnO are analysed on the basis of a co tinuously non-uniform surface. [For earlier app cations of this idea see Abstr. 326 (1949); 1291 (1950 These results appear to be satisfactorily explaine but the experimental data are not sufficiently extens to justify the evaluation of parameters. J. IBA

541.1

9083. Adsorbed films at oil-water interfaces. E. Cockbain and A. J. McMullen. *Trans Farad Soc.*, **47**, 322–30 (*March*, 1951).

The adsorption of potassium laurate and sodi dodecyl sulphate at the benzene-water and *n*-decan

water interfaces has been calculated from Gibbs' equation; the relationship between the calculated adsorption and the surface concentration of spread monolayers of paraffin chain salts is discussed. Interfacial tension and adsorption data are given for a number of four-component systems containing oil-soluble and water-soluble components (including cholesterol, sitosterol and soaps). Evidence is presented that molecular interaction at the interface is a factor of minor importance in determining the interfacial tension and composition of the mixed adsorbed film. A.

541.183

9084. Adsorption of polar organic compounds on steel. E. L. Cook and N. Hackerman. *J. Phys. Coll. Chem.*, **55**, 549–57 (*April*, 1951).

The adsorption from solution of higher-molecular-weight aliphatic acids, amines, alcohols and certain esters on SAE 1020 steel powder with a specific surface area of 0·10 m^2/g has been studied. Two types of adsorption, irreversible and reversible, were observed for these systems. The extent of total adsorption was a function of molecular weight and the polar group. It was found to exceed the calculated amount necessary for a complete close-packed monolayer by 20–70%, depending on the compound. The extent of irreversible adsorption was independent of molecular weight, and characteristic of the functional group of the series. Calculated surface coverage in these cases was between 10 and 50%. A.

541.183

9085. Sorption hysteresis. I. Some factors determining the size of the hysteresis loop. A. G. Foster. *J. Phys. Coll. Chem.*, **55**, 638–43 (*May*, 1951).

A review of existing data on sorption hysteresis shows that the size of the loop decreases (*a*) with increasing temperature, and (*b*) with increasing molecular diameter. The ink-bottle theory offers no explanation of these facts, both of which are in complete agreement with the predictions of the open-pore theory. A.

541.183

9086. Adsorption of mixed films on activated carbon. B. S. Harrap. *Trans Faraday Soc.*, **47**, 645–9 (*June*, 1951).

Data are presented on the mutual influence of aniline and oleyl alcohol on their adsorption on activated C and on the influence of the *p*H of the system on the adsorption of both materials. The capacity of the C for the adsorption of oleyl alcohol was determined using a Langmuir-type surface balance to detect any excess alcohol over that adsorbed at the C-water interface. It is suggested that the same adsorption sites are available at the C-water interface for both aniline and oleyl alcohol molecules; on this assumption the relative binding affinities of the two molecules for the C surface have been calculated. A.

541.183 : 536.7

9087. Thermodynamics of adsorption. T. L. Hill. *Trans Faraday Soc.*, **47**, 376–80 (*April*, 1951).

In reply to a paper by D. H. Everett [Abstr. 7573 (1950)]. The discussion concerns utility and completeness rather than correctness of different thermodynamic points of view in adsorption work. The B.E.T. theory is used as an illustration. It is concluded that for a one-component system, one is more interested, for purposes of interpretation, in the molar integral than in the differential energy and entropy of adsorbed molecules; "solution thermodynamics" is the natural approach to the differential quantities; "adsorption thermodynamics" is the natural approach to the molar integral quantities; however, more extensive data and calculations are necessary to obtain the molar integral quantities. A.

541.183.1

9088. Huttig's multilayer isotherm. R. M. Barrer. *J. Chem. Soc.* (1951) 1874–6 (*July*).

Huttig's isotherm cannot be interpreted physically in terms of B.E.T. (Brunauer–Emmett–Teller) molecular columns. The Huttig isotherm is thermodynamically consistent with a succession of layers in a potential field, vertical interactions between sorbate molecules in successive layers being omitted. Lateral interactions are, however, allowed. The isotherm is thus complementary to the B.E.T. isotherm where vertical interactions are introduced and lateral interactions are omitted. The Huttig potential normally proves to be the equivalent of a London–van der Waals potential due to the surface together with a potential due to lateral interaction. A.

541.183.2

9089. Multilayer sorption in terms of an equation of state. R. M. Barrer and A. B. Robins. *Trans Faraday Soc.*, **47**, 773–87 (*July*, 1951).

A new approach to multilayer sorption has been developed which makes use of van der Waals' equation of state for the sorbed gas or vapour. Nitrogen and water molecules, representing contrasts in polarity, have been investigated as sorbates. Through the equation of state both vertical and lateral interactions between sorbed molecules are approximately allowed for. The treatment shows that (1) multilayer formation occurs below the critical temperature, and that a boundary between a densely populated film and a dilute region may move slowly outward as p/p_0 increases. The film surface is smooth. Except when p/p_0 approaches unity the total sorption amounts to a few monolayers only. (2) On plane surfaces allowing unrestricted sorption, nitrogen gives Langmuir-like isotherms above its critical temperature (Type I in Brunauer's classification), and sigmoid (Type II) isotherms near its boiling temperature. Water on the other hand in unrestricted sorption may give isotherms of Types I, II and III. (3) In the spaces between parallel plates or in cylindrical capillaries open at both ends, nitrogen gives Type IV isotherms and water gives isotherms of Types IV or V according to the relative values of $2a/b$ and $-E_1$. (4) Capillary structure and dimensions strongly modify the form of the calculated isotherms. A.

541.183.2

9090. The anomalous first layer of adsorbed helium and a modified B.E.T. theory. J. G. Aston and S. V. R. Mastrangelo. Letter in *J. Chem. Phys.*, **19**, 1067–8 (*Aug.*, 1951).

The Brunauer–Emmet–Teller theory is modified

by assuming that the lower layers are solid and have therefore a higher energy than the upper (liquid) layers. H. LONDON

541.183.26 : 533.15

Flow of gases and vapours in a porous medium and its bearing on adsorption problems. *See Abstr.* 8570–1

541.183.26 : 536.63

9091. The heat capacity of multimolecular layers of adsorbed argon. J. A. MORRISON AND L. A. DRAIN. Letter in *J. Chem. Phys.*, **19**, 1063 (*Aug.*, 1951).

The heat capacity maxima obtained are interpreted as pointing to rearrangement in the adsorbed film, equivalent to fusion in the bulk substance. Partial molar heat capacities of the adsorbed A have been calculated. Calculation of molar heat capacity for the temperature interval 65–83°K gives approximately the heat of fusion of A. F. LACHMAN

CHEMICAL STRUCTURE 541.4/.6

541.51

9092. The valencies of the transition elements in the metallic state. W. HUME-ROTHERY, H. M. IRVING AND R. J. P. WILLIAMS. *Proc. Roy. Soc. A*, **208**, 431–43 (*Sept.* 24, 1951).

The melting-points, interatomic distances and compressibilities of the transition elements are reviewed, and are shown not to be in complete agreement with the valency scheme proposed by Pauling. In all three Long Periods on passing from Groups IA to IVA there is a steady rise in melting-point, and decrease in interatomic distance and compressibility, and for these elements Pauling's view of a metallic valency equal to the Group number is correct. In the First Long Period there is comparatively little increase in melting-point on passing from Ti to V and Cr, in contrast to the behaviour of the corresponding elements in the later Periods where the melting-points rise steeply to a maximum in Group VI. This suggests that in Groups VA and VIA the metallic valency is less for the elements of the First Long Period than in the later Periods, and this agrees with the general inorganic chemistry of the elements. The same principle is shown to hold for the elements of Groups VII A and VIII, and a new scheme of metallic valencies is suggested which appears attractive in several ways. A.

541.515

9093. Free valence in unsaturated hydrocarbons. F. H. BURKITT, C. A. COULSON AND H. C. LONGUET-HIGGINS. *Trans Faraday Soc.*, **47**, 553–64 (*June*, 1951).

Theoretical values of free valence in conjugated hydrocarbons are compared with calculated polarization energies for radical attack at different positions. In alternant hydrocarbons a close correlation is found between the two sets of quantities, indicating that the free valence will generally give a semi-quantitative measure of activity towards free radicals. In non-alternant hydrocarbons, however, the correlation between free valence and polarization energy is poor, showing that predictions of radical reactivity base on free valence calculations are unreliable.

541.57

9094. Bond–bond interactions in linear and angula molecules. J. DUCHESNE AND L. BURNELLE. *J. Cher Phys.*, **19**, 1191–4 (*Sept.*, 1951).

The vibration potential function of several mol cules is studied with special emphasis on the bonc bond interaction terms. It is shown that in the ca of molecules with localized bonds a satisfacto correlation of the results cannot be obtained witho assuming the existence of a maximum in the bonc bond energy curve. This maximum presumab arises from the electrostatic interactions between th bond orbitals. As a result, the bond–bond interactio terms may be either positive or negative, accordin to the position of the point which represents th equilibrium position of the molecule on the curv However, this sign seems generally positive, exce for molecules with hydrogenated bonds. On the othe hand, for molecules with delocalized bonds (resonanc a general law may be formulated for the behaviou of these terms when they refer to nonadjacent as we as to adjacent bonds. In those cases, the part playe by the electrostatic interactions seems to be dominate by the resonance effects.

541.61

9095. Structure of clathrate compounds. H. M POWELL. *Nature, Lond.*, **168**, 11–14 (*July* 7, 1951).

These compounds form cavities of well define shape in which a second compound is enclosed an held by no ordinary bonds. Molecules of simila physical properties but different structures ma therefore be separated if allowed to be caged i suitable enclosure compounds. J. JACOI

541.634 : 539.13

9096. A study of the stereochemistry of acraldehyd and crotonaldehyde by the electron diffraction metho H. MACKLE AND L. E. SUTTON. *Trans Faraday Soc* **47**, 691–9 (*July*, 1951).

The configurations of acraldehyde and of croto aldehyde in the gaseous phase have been investigate by electron diffraction. No attempt has been mad to evaluate all the parameters necessary to descri the molecules; but the diffraction patterns have bee shown to be consistent with the following values fo the bond distances (*a*) in acraldehyde C_1—O = 1·21 ± 0·02 Å, C_2—C_3 = 1·36 ± 0·02 Å; (*b*) i crotonaldehyde C_1—O = 1·21 Å, C_2—C_3 = 1·36 C_3—C_4 = 1·52 Å. They are also consistent wit the angles C_2C_1O and $C_1C_2C_3$ (assumed equa being 120° ± 3°. An independent value of 1·46 ± 0·03 Å has been obtained for the C_1—C_2 distance i acraldehyde. The radial distribution curves provid strong evidence for the co-existence of planar an *s-cis* and *s-trans* isomers in both cases; and the tria and-error analyses support these conclusions. Th proportions are very roughly 1/3 for acraldehyde an 1/1 for crotonaldehyde. The effect of temperatu upon the equilibrium is briefly discussed. Fo crotonaldehyde, *s-cis*: *d-cis* and *s-trans*: *d-cis* isome are shown to be inconsistent with the observe diffraction patterns.

541.64

9097. The volume requirements of polymer molecules. I. The apparent specific volume of polystyrene in solution. W. HELLER AND A. C. THOMPSON. *J. Coll. Sci.*, **6**, 57–74 (*Feb.*, 1951).

The apparent specific volume of polystyrene was determined at 25·00°c in chlorobenzene and bromobenzene. The results are compared with and discussed on the basis of recent density measurements of bulk polystyrene by Flory and Fox. The results indicate that care must be taken in interpreting volume changes observed on mixing solid polymers with solvents. It is proposed to characterize the apparent second-order transition by an alternation of configurational probability in neighbouring volume elements. The resulting "microstrain" and cavitation allow a simple explanation of phenomena associated with an apparent second-order transition such as brittleness. Slight divergencies between the apparent specific volume observed and expected in solution and an analysis of pertinent literature data show that the apparent specific volume changes appreciably with the nature of the solvent. The probable effect of molecular weight upon solution densities and the question of density measurements for rapid molecular weight determinations are discussed briefly by means of extrapolations from data obtained by Flory and Fox. A.

541.64

9098. Studies of the sedimentation, diffusion and viscosity of some sarcosine polymers in aqueous solution. J. H. FESSLER AND A. G. OGSTON. *Trans Faraday Soc.*, **47**, 667–79 (*June*, 1951).

The homogeneity of the samples was shown to be of the order predicted from the method of synthesis. The degrees of polymerization attained were always less than expected and this is ascribed to water acting as a chain-starter. The variation of the sedimentation constant with concentration is shown to be in agreement with a theory based on the treatment of flow through a porous plug. The results on the diffusion coefficients and intrinsic viscosities are used to test agreement with three theories of the dynamic properties of chain polymers. The dimensions of the molecule calculated from the several theories are compared. A.

541.64 : 532.72

9099. On the measurement of the constant of the diffusion of polymers. P. A. FINOGENOV. *J. Tech. Phys., USSR*, **21** (*No.* 2) 167–77 (1951) *In Russian.*

Describes two principal methods of determining the diffusion constant of polymers. Formulae are given for the computation of the diffusion constant, as well as practical methods of computing. A special attachment for the automatic photographing of the diffusion is described. F. LACHMAN

541.65 : 535.323

9100. The molecular refractivity of glasses. A. WINTER-KLEIN. *C.R. Acad. Sci., Paris*, **233**, 301–3 (*July* 23, 1951) *In French.*

The components of silica glasses contribute additively to the molar refractivity, $R = M(n^2 - 1)/d(n^2 + 2)$, but the amount contributed varies slightly according to whether the glass is quenched or annealed. For eight oxides, the average additional contribution to R per bond due to annealing is roughly proportional to the energy of the corresponding oxide bond. R. O. DAVIES

541.65 : 535.551

Molecular lengths from flow birefringence data. *See Abstr.* 8664

541.67

9101. Magnetochemistry of the complexes of quadricovalent Cu^{++} and Ni^{++}. J. PLOQUIN. *C.R. Acad. Sci., Paris*, **233**, 162–4 (*July* 9, 1951) *In French.*

Magnetic evidence for the structures of complexes of heterocyclic amines with quadricovalent Cu^{++} and Ni^{++} is given. W. R. ANGUS

541.67 : 538.222

Molecule structure from paramagnetic resonance absorption. *See Abstr.* 8846

LABORATORY APPARATUS 542.1/.7

542.48 : 536.423

9102. Theory of distillation and other countercurrent processes. II. W. R. VAN WIJK. *Physica*, **17**, 485–500 (*May*, 1951).

The theory of countercurrent processes presented in a previous article [Abstr. 3487 (1950)] is further developed. An analytical solution of the basic equation, from which the product of absorption factors is calculated, is given. A theoretically sound procedure for reducing the distillation of a multicomponent mixture to that of two binary mixtures is developed. Algebraic as well as graphical methods can be used to perform the actual calculation. The influence of unspecified components on the absorption factor product is discussed. A.

542.73 : 533.5

9103. A system for handling gases without stopcock grease. M. E. REINDERS AND J. KISTEMAKER. *Appl. Sci. Res.*, **B2** (*No.* 1) 71–2 (1951).

542.78

9104. Valve for pure gases compressed to pressures of the order of 1 000 atmospheres. S. ROBIN AND B. VODAR. Letter in *J. Phys. Radium*, **12**, 699 (*June*, 1951) *In French.*

Constructional details, with drawing, are given of a steel needle valve of standard design using a Pb washer and useful for the fine control of flow of gas. S. WEINTROUB

CHEMICAL ANALYSIS 543/545

545.3 : 537.363

9105. Ionography: Some aspects of ion migration on paper in an electric field. H. J. MCDONALD, M. C. URBIN AND M. B. WILLIAMSON. *J. Coll. Sci.*, **6**, 236–44 (*June*, 1951).

The relationships that exist between the mobility of amino acids migrating on paper under the influence of

an electric field, and the *p*H of the solution, the ionic strength, the time and the voltage across the paper are presented. The rate of migration bears a linear relation to the potential gradient and to the time. The isoelectric points of histidine and glutamic acid have been determined to be 7·6 and 3·1, respectively. A.

545.3 : 537.363

9106. Two-dimensional electrophoresis and ionophoresis. E. L. DURRUM. *J. Coll. Sci.*, **6**, 274–90 (*June*, 1951).

The author has reported recently [*J. Amer. Chem. Soc.*, **72**, 2943 (*July*, 1950)] a unidimensional microelectrophoretic technique in which an electrical potential is applied across the ends of strips of filter paper saturated with buffer or other electrolyte solutions. To these strips are applied at intermediate areas, mixtures of charged substances to be separated. The present report is concerned with the extension of this method of separation in a manner analogous to two-dimensional paper chromatography. The method depends upon the fact that certain charged materials exhibit relative differences in mobilities at different *p*H values under the influence of an electrical field. The phenomenon of "mobility equilibrium" is described and a hypothesis proposed to explain it. A.

545.32

9107. Electrolytic determination of cadmium in zinc sulfide-cadmium sulfide phosphors. R. BASTIAN, R. WEBERLING AND F. PALILLA. *J. Electrochem. Soc.*, **98**, 307–10 (*Aug.*, 1951).

A rapid electrolytic method for determining Cd in ZnS/CdS phosphors is presented. From 0·2 to 0·7 g of Cd is plated from a sulphuric acid K bisulphate solution containing up to 3 g of Zn. Cd deposition is not quite complete but the amount remaining in solution is so nearly constant that a correction can be made for it. When this is done an average accuracy and precision of about one part per thousand is obtained. A.

545.37

9108. Oscillographic polarography. Improved method of measurement and causes of errors. P. DELAHAY AND G. L. STIEHL. *J. Phys. Coll. Chem.*, **55**, 570–85 (*April*, 1951).

The following causes of error affecting the height of a polarographic wave have been investigated: variation of the sensitivity of the instrument, distortion of the wave by capacity current, influence of the initial potential of the voltage wave, influence of the resistance of the circuit, distortion of the voltage wave, possible fluctuations in the anode potential, and fluctuations in the drop time. An equation is derived for the capacity current. The distortion of a wave by a previous one in the case of successive waves is investigated. A method for the resolution of simultaneous waves is described. Several improvements in the experimental method are also described. A.

545.37

9109. Oscillographic polarography. Phenomena occurring during the quiescent period of the voltage wave. P. DELAHAY AND G. PERKINS. *J. Phys. Coll. Chem.*, **55**, 586–91 (*April*, 1951).

The influence of the anodic and the diffusion processes taking place during the quiescent period of the voltage wave is investigated. In the case of an irreversible electrode reaction, the concentration of reducible material before each new sweep of potential decreases as the Hg drop grows. This effect, together with the rate of the cathodic process, accounts for the curvature of the diagram $I = f(v^{1/2})$ observed in the case of irreversible reactions. The dependence of the maximal peak current on the head of Hg in the case of an irreversible electrode reaction is also explained. The influence of the shape of the voltage wave on the maximal peak current is investigated. Experimental evidence is presented to support the various explanations advanced in the present paper. A.

545.37

9110. Direct estimation of the electrons involved in polarographic reduction. G. A. GILBERT AND E. K. RIDEAL. *Trans Faraday Soc.*, **47**, 396–400 (*April* 1951).

Electrolysis in a micro-cell has been used for the direct determination of the number of electrons per molecule involved in polarographic reduction. The validity of the method has been confirmed using cadmium ion, and the results have been checked by simultaneous application of the Ilkovic equation. It has been shown that the electro-reduction of a certain azo-sulphonate dye ion requires four electrons, and that this particular dye therefore undergoes scission at the azo group. An amine and an amino-phenol are formed, the amino-phenol being subsequently anodically oxidized to an imino-quinone unless the anode is isolated by a salt-bridge. A.

545.37

9111. A test of the diffusion term in the Ilkovic equation. J. J. MACDONALD AND F. E. W. WETMORE. *Trans Faraday Soc.*, **47**, 533–8 (*May*, 1951).

Single-drop polarography has been carried out with the system $CuSO_4 + H_2SO_4 + H_2O$, in which the diffusion coefficient of Cu is known with accuracy. Instantaneous currents were obtained as a function of time by means of an oscillograph of rapid response for various conditions of Cu concentration, acid concentration, impressed voltage, temperature, drop time and capillary dimensions and geometry. The results are in fair agreement with the Ilkovic equation particularly in the form for averaged current. The equations proposed by Lingane and Loveridge and by Strehlow and von Stackelberg give values consistently higher than found experimentally. The order of the current-time parabola was found to lie between 4 and 5. A.

545.37

9112. Constant-current supply for colorimetric analysis. C. N. REILLEY, W. D. COOKE AND N. H. FURMAN. *Analyt. Chem.*, **23**, 1030–2 (*July*, 1951).

545.37

9113. Metal-solution potentials of nickel in foreign ion solutions. D. MACGILLAVRY, J. J. SINGER, JR. AND J. H. ROSENBAUM. *J. Chem. Phys.*, **19**, 1195–1202 (*Sept.*, 1951).

Nickel may show stationary potentials in K hydroxide and phosphate buffer solutions, if oxygen is excluded. The stable potentials are reversible with respect to a change of *p*H. It was noted that Ni was

unable to displace H from a 0·1M phosphoric acid solution; Ni dissolved only on admission of air. The possibilities of interpreting the observed potentials are discussed. A.

545.372

9114. Vibrating dropping mercury electrode for polarographic analysis of agitated solutions. D. A. BERMAN, P. R. SAUNDERS AND R. J. WINZLER. *Analyt. Chem.*, **23**, 1040–1 (*July*, 1951).

545.8

9115. Estimation of radioactive hydrogen as tritiobutane in the Geiger counter. R. F. GLASCOCK. Letter in *Nature, Lond.*, **168**, 121–2 (*July* 21, 1951).

Full details are given of the preparation of butane from samples (*c.* 10 mg) of radioactive water. The choice and performance of suitable counting tubes is described. L. E. MUSSELL

545.8

9116. Radiochemical techniques in analysis. F. P.W. WINTERINGHAM. *Nature, Lond.*, **168**, 153–5 (*July* 28, 1951).

A summary of papers read at a meeting of the Society of Public Analysts in May, 1951, dealing with applications of the method to quantitative paper chromatography techniques, the paper chromatography of penicillin mixtures labelled with radioactive S-35, the ultra-micro determination of As by neutron activation, and activation analysis applied to the determination of down to 0·05 μg of Na and 5 μg of K in biological samples. The method is unsuitable for the determination of B in plant material, as B gives no suitable isotope on neutron irradiation. A simple automatic device is described (in the original) for exposing consecutive sections of a paper chromatogram for a given time, to a screened end-window G.M. tube under standard conditions, and for plotting the mean rate of count against the distance along the strip. J. GRANT

545.82

9117. New instruments for technical extinction measurements. G. HANSEN. *Optik*, **8** (*No.* 6) 251–77 (1951) *In German.*

The use of extinction measurements for the determination of concentration in chemical analysis is reviewed, and the relative merits of present visual and electrical instruments discussed. Two new photoelectric photometers are described, one using a light "chopper" and a.c. amplifier, the other a double cell comparison method. Practical details and accuracies achieved are given. 11 references. R. W. FISH

545.82

9118. Re-examination of the infrared spectra of the monodeuterotoluenes: a method of analysis. G. VAN D. TIERS. Letter in *J. Chem. Phys.*, **19**, 1072 (*Aug.*, 1951).

The infrared spectra of toluene and the three monodeutero toluenes have been determined from 3 to 27 μ. Satisfactory quantitative analyses of mixtures containing these four components have been made using characteristic bands from 13 to 17 μ. W. R. ANGUS

545.82

9119. A general method of quantitative spectrographic analysis. C. BERSANO. Note in *Nuovo Cim.*, **8**, 577–83 (*Aug.*, 1951) *In Italian.*

Discusses a new working method for the quantitative determination of an element by spectrographic analysis, which offers greater generality and simplicity than existing methods. A.

545.822

9120. Studies on quantitative emission spectrum analysis. III. Quantitative analysis of boron by the solution method. S. MUSHA. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 437–42 (*June*, 1950).

For Pt II, see Abstr. 6554 (1951). Describes a new electrode form for the analysis of boron in solution and discusses in some detail the accuracy of the results. The effect of altering certain circuit parameters on the spark excitation is briefly described. Zn is used as an internal standard. J. D. CRAGGS

545.844

9121. A simplified coupled filter system for adsorption chromatography. D. A. HALL. Letter in *Nature, Lond.*, **168**, 124 (*July* 21, 1951).

Describes a simplified filter system combining, it is claimed, all the advantages of Hagdahl's original apparatus with a much greater ease of production and assembly. The filters are made of "Perspex." F. LACHMAN

CRYSTALLOGRAPHY 548

548.1 : 51

9122. The theorem of the emptiness (primitiveness) of the fundamental parallelepiped of a crystal lattice. N. V. BELOV. *Dokl. Akad. Nauk, SSSR.*, **78** (*No.* 1) 55–8 (1951) *In Russian.*

The following theorem was first proved by Dirichlet using the method of Fedorov parallelohedra (Voronov regions). If the lattice of any crystal is constructed and is moved parallel to itself so that its origin is placed at any required point in the crystal then all homologous points of the crystal must lie only at the corners of the resulting parallelepipeds and not inside them nor on faces nor edges. A simplified version of Dirichlet's proof, but almost without calculation, is given. A. L. MACKAY

548.12 : 513.771

Homology space groups. *See Abstr.* 8420

548.33

9123. Polymorphism in potassium niobate, sodium niobate, and other ABO_3 compounds. E. A. WOOD. *Acta Cryst.*, **4**, 353–62 (*July*, 1951).

Potassium niobate is orthorhombic at room temperature, changing to tetragonal at about 225°C and cubic near 435°C. Sodium niobate is orthorhombic at room temperature, changing to tetragonal at about 370°C and to cubic at about 640°C. The second part of the paper discusses relations among the structures of the ABO_3 compounds. A.

548.51

9124. The rate of growth of nuclei in the dehydration of hydrates. R. S. BRADLEY. *Trans Faraday Soc.*, **47**, 630–32 (*June*, 1951).

It is suggested that the observations of Cooper and Garner on the relatively slow rate of growth of small nuclei formed on the surface of hydrates *in vacuo* may be due to the effect of the dehydrated phase on the activation energy necessary for the escape of water molecules. A theoretical treatment shows that log (da/dt), where a is the radius of a nucleus, is a linear function of $1/a$, as Cooper and Garner found over the region for which da/dt was not a constant. A.

548.52

9125. Observation of growth of cadmium iodide from aqueous solution. A. J. FORTY. Letter in *Phil. Mag.*, **42**, 670–2 (*June*, 1951).

Describes microscopical observations of the screw-dislocation-induced [Abstr. 1343 (1950)] spiral growth of (0001) faces. Individual growth layers are of very much more than monomolecular thickness, as previously observed for beryl [Abstr. 6145 (1950)] and for paraffin crystals [Abstr. 4790 (1951)]. This is attributed to the growth being initiated by "dislocation groups," one or more in number according to the details of the growth pattern, each with a "considerable" total Burgers vector—about 110 times the minimum value in the case of an observed layer thickness of 750 Å. A. D. LE CLAIRE

548.54

9126. Anomalous co-crystallization of radioactive trace quantities of foreign ions with sodium chloride crystals. I. Correlation with crystallographic effects. A. H. BOOTH. *Trans Faraday Soc.*, **47**, 633–40 (*June*, 1951).

Evidence from typical examples (lead and cadmium in NaCl) suggests that the formation of trace-scale "anomalous mixed crystals" is caused by adsorption of the foreign ions on specific crystal planes. The process is thus related to crystal habit modification, but not all habit modifiers form such systems. Among a group of metal ions, all of which modify the habit of NaCl, Cd and Pb co-crystallize strongly with NaCl from solutions containing the foreign ions in radioactive trace amounts, whilst Zn, Mn, Hg and Bi do not. Apparently the trace-scale phenomenon occurs only when the adsorption is exceptionally strong, for the exceptional behaviour of Cd and Pb is paralleled in other crystallographic effects which have been attributed to adsorption. Pb and Cd chlorides strongly inhibit crystallization of NaCl, thicken the crystallization layers and form oriented overgrowths on the (100) face. The other metal salts exhibit these effects weakly or not at all. The sharp distinction between the two groups of habit modifiers is compatible in some respects with the lattice-fitting hypothesis of the adsorption mechanism, but the possible importance of other factors is not excluded.

548.54

9127. Anomalous co-crystallization of radioactive trace quantities of foreign ions with sodium chloride crystals. II. An examination of the criteria distinguishing anomalous mixed crystals from internal adsorption compounds. A. H. BOOTH. *Trans Faraday Soc.*, **47**, 640–5 (*June*, 1951).

The objections to regarding the incorporation of ThB in NaCl as an adsorption process are examined in detail. The criteria for distinguishing "anomalous mixed crystals" from "internal adsorption compounds" are shown not to hold in this case. The inclusion of ThB in the crystals can be prevented by the presence of an excess of another adsorbable substance (Cd ions) and cubo-octahedral crystals show, in auto-radiographs, a localized distribution of the ThB. Quantitatively, the inclusion of ThB does not resemble a substitution reaction. The logarithmic partition coefficient λ is not numerically equal to the distribution coefficient D. Furthermore, the inclusion takes place only during active crystal growth; ThB does not migrate into the NaCl crystals during recrystallization unless there is active growth of small crystallites to larger ones. It is concluded that the distinction between the two classes of trace-scale co-crystallization is of doubtful value. A.

548.57

9128. Etching cavities and figures on single crystals of magnesium. I. OGURA. *J. Sci. Hiroshima Univ. Ser. A*, **15**, 51–5 (*March*, 1951).

The etching of cavities and figures on single crystal plates of magnesium has been studied. Ammonium chloride in solutions of various concentrations was employed as etching reagent. It has been found that the etched cavities varied with the kind of specimen and especially with the crystallographic surface. The corrosive phenomena also varied with the crystallographic surface. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 538.11

Statistics of the simple cubic lattice. *See Abstr.* 8836

548.7 : 548.

9129. Dislocations as lattice states and their significance for plasticity and growth of crystals. II. A. KOCHENDÖRFER. *Phys. Bl.*, *No.* 6, 252–9 (1951) *In German.*

For Pt I, see Abstr 6569 (1951). The methods of calculating lattice dislocations in the static case are surveyed. Peierls's procedure [*Proc. Phys. Soc. Lond. A*, **52**, 34 (1940)] is the most effective, but presents mathematical difficulties; a method has now been developed to obtain solutions to Peierls's equations from solutions of Frenkel's equations [*J. Phys. USSR*, **1**, 137 (1939)]. Frenkel's method is applied to the dynamic case for calculating movements of dislocations and diffusion phenomena. J. A. FRANK

548.73 : 531.717.

9130. A non-destructive X-ray method for the determination of the thickness of surface layers. P. GAY AND P. B. HIRSCH. *Brit. J. Appl. Phys.*, **2**, 218–22 (*Aug.*, 1951).

The intensity of reflection of a parallel, monochromatic X-ray beam is measured as a function of

the angle (ϕ) between the lines given by the intersection of the plane of incidence with (*a*) the surface, and (*b*) the reflecting planes of the matrix crystal. If a surface layer is present, both incident and reflected beams suffer absorption. A general expression is quoted for the intensity (which falls to zero when ϕ = the Bragg angle) in terms of the geometrical, absorption and intensity constants, it being shown how a suitable plot of functions of the experimental values yields the layer thickness. Experimental procedure for single crystal and polycrystalline bases is explained and brief results are shown for an abraded surface on a LiF crystal, and for an Al layer on polycrystalline Cu. The method is applicable to all layers with reflection coefficients different from that of the matrix. A. J. KENNEDY

548.73 : 539.32

9131. Determination of elastic constants from diffuse reflexions of X-rays. I. Theory of method. G. N. RAMACHANDRAN AND W. A. WOOSTER. *Acta Cryst.*, **4**, 335–44 (*July*, 1951).

This paper describes the use of a Geiger-counter spectrometer for measuring the intensity of the very weak beams of X-rays diffusely reflected from crystals in directions close to, but not coincident with, those corresponding to Bragg reflections. The reflected beam, being diffusely scattered, is limited by the dimensions of the various slits, and corrections are necessary to allow for the effects of divergence in the beams. Corrections for Compton scattering, for the effects of white radiation and for the mosaic texture of the crystal are also given. The theoretical principles by which the observations may be related to the elastic constants are discussed, and a particular method of selecting the experimental data to give the ratio of elastic constants of cubic crystals is indicated. The main part of the diffuse scattering is due to X-rays which have been scattered from only one elastic wave. A small part is due to X-rays which have been scattered from two elastic waves, and the analysis is given by which a correction for the second-order diffuse scattering may be made. A.

548.73 : 539.32

9132. Determination of elastic constants of crystals from diffuse reflexions of X-rays. II. Application to some cubic crystals. G. N. RAMACHANDRAN AND W. A. WOOSTER. *Acta Cryst.*, **4**, 431–40 (*Sept.*, 1951).

The formulae required to deduce the elastic constants of cubic crystals from observations of diffuse reflections are derived from the general theory. The intensities of the diffuse reflections corresponding to points in reciprocal space distributed along various lines are compared. These lines are always taken in pairs which pass through the same reciprocal-lattice point, e.g. 400, and are parallel to important crystallographic axes, e.g. [110], [111]. Comparisons of these diffuse intensities lead directly to a measurement of ratios of the three elastic constants c_{11}, c_{12}, c_{44}, with an accuracy of about 5%. Absolute values can be determined from an absolute measurement of the diffuse intensity, though with a lower accuracy. The method was tested using crystals of KCl and KBr and found to give results in agreement with measurements by other methods. It was also applied to $NaClO_3$, galena PbS, and hexamethylenetetramine. The last crystal was chosen as an example of a soft organic crystal which could not easily be studied by other methods, and it is believed to be the first purely organic cubic crystal for which the elastic constants have been determined. A.

548.73/.74 : 539.26/27

X-ray and electron investigation of materials. *See Abstr.* 9017–23

548.732

9133. X-ray optics with crystal reflection. H. WILSDORF. *Naturwissenschaften*, **38** (*No.* 11) 250–8 (1951) *In German.*

Discusses the optics of plane monochromators and various types of curved-crystal focusing monochromators (cylindrical, double cylindrical, logarithmic spiral, and elliptical); also methods of image formation with X-rays using bent crystals. 59 references. A. R. STOKES

548.734.3

9134. The scatter of diffraction spots on X-ray back-reflection photographs. G. FROHNMEYER. *Z. Naturforsch.*, **6a**, 319–31 (*June*, 1951) *In German.*

To elucidate the cause of the scatter of diffraction spots, back-reflection photographs were taken, with monochromatic X-rays, of pure strain-free Al, and of vacuum-annealed Cr powder. Two types of monochromator were used: a single bent quartz crystal and a double-crystal arrangement. All diffraction spots lay on Debye–Scherrer rings within very small limits of variation. The scatter of spots usually observed is thus due to lack of monochromatism of the incident X-ray beam. A. R. STOKES

548.735

9135. Multiplicity of solutions of crystal-structure equations. H. HAUPTMAN AND J. KARLE. Note in *Acta Cryst.*, **4**, 383 (*July*, 1951).

See Abstr. 1493, 3921 (1951).

548.735

9136. X-ray diffraction by structures in disordered layers. I. G. W. BRINDLEY AND J. MÉRING. *Acta Cryst.*, **4**, 441–7 (*Sept.*, 1951) *In French.*

While the approximations in the theoretical treatments of X-ray diffraction by two-dimensional gratings are in many cases valid and justify the application of the resultant formulae (in particular the Laue–Warren formulae) to the interpretation of experimental data, in certain cases a more detailed treatment is required. The present paper is concerned with the variation of the structure factor F within the zone of integration involved in determining the reflected intensity from a random powder of two-dimensional gratings. This integration is resolved into two parts corresponding to integration (*a*) across, (*b*) along the diffuse lines which represent two-dimensional layer lattices in reciprocal space; (*a*) is carried out algebraically, and the results are tabulated numerically for crystals of three simple shapes; (*b*) must be performed numerically for each individual case in accordance with the variation of F. The application of the formulae derived is discussed in relation to cases for which the variation of F^2 with angle is (i) slow, (ii) rapid and negative, (iii) rapid and positive, and the three types of diffracted bands

are indicated. Results obtained by the present method and by the use of the Warren formulae are compared. A.

548.735.44

9137. The calculation of structure factors by Fourier summation. D. SAYRE. *Acta Cryst.*, **4**, 362–7 (*July*, 1951).

A method is described by which the structure factors of a proposed crystal can be calculated by sampling of the proposed unit cell followed by harmonic (Fourier) rather than non-harmonic summation. It is suggested that rapid computing devices may be used more advantageously with this than with the present methods, and that the advantage would be particularly great for structures with many atoms or with non-spherical atoms. The nature of the inherent error is discussed and a method for eliminating it is presented; an example of the use of the method is given, with a comparison of the results with those obtained by the ordinary method; and strips for "hypothetical" two-dimensional C, N and O atoms are given. A.

548.735.44

9138. On the convergence and the error in non-centrosymmetric structures. V. LUZZATI. *Acta Cryst.*, **4**, 367–9 (*July*, 1951) *In French.*

Some conclusions obtained by Cruickshank [Abstr. 3520 (1950)] are confirmed by a more direct method: (1) The method of successive applications of the Fourier transform is convergent for non-centrosymmetric structures. (2) Under identical conditions, the error in atomic positions is twice as great for non-centrosymmetric as for centrosymmetric structures. A.

548.735.44

9139. Some properties of the $(F_o - F_c)$-synthesis. W. COCHRAN. *Acta Cryst.*, **4**, 408–11 (*Sept.*, 1951).

It is shown that a Fourier synthesis whose coefficients are the differences of observed and calculated structure factors has a number of properties which make it useful for accurate crystal-structure analysis The use of this synthesis for the refinement of atomic co-ordinates and temperature-factor parameters is discussed and its equivalence to certain other methods is demonstrated. A.

548.735.44

9140. Diffraction effects in X-ray Fourier syntheses due to non-observed "weak reflexions." A. MAGNÉLI. *Acta Cryst.*, **4**, 447–50 (*Sept.*, 1951).

A crystal structure in which displacements of certain atoms suddenly occur at long, regular intervals gives strong X-ray reflections only in the close vicinity of reciprocal-lattice points, corresponding to the period of the basic sublattice. If the remaining reflections, which may be very weak, are not detectable by the experimental method applied, then larger diffraction effects can appear in the Fourier calculations of the electron-density function based on the observed X-ray data. A.

548.735.44

9141. Optical methods in X-ray analysis. II. Fourier transforms and crystal-structure determination. H. LIPSON AND C. A. TAYLOR. *Acta Cryst.*, **4**, 458–62 (*Sept.*, 1951).

For Pt I, see Abstr. 6579 (1951). The optical apparatus described in Pt I can be used to determine experimentally the Fourier transforms of two-dimensional projections of atomic arrangements. Methods of using these transforms to determine crystal structures are surveyed, and examples of their application to certain known structures are described. Since no calculation is involved, trial-and-error methods can be carried through very rapidly, and under certain circumstances direct crystal-structure determination is possible. Ways of extending this process of direct crystal-structure determination are discussed. A.

548.735.44 : 535.4

9142. Fourier synthesis by optical interference. A. W. HANSON, C. A. TAYLOR AND H. LIPSON Letter in *Nature, Lond.*, **168**, 160 (*July* 28, 1951).

A development of Bragg's method [*Nature, Lond.* **143**, 678 (1939)]. Slips of mica between crossed Nicols give variable amplitude, positive or negative. A. R. STOKES

548.736.1

9143. Structures of uranium. J. THEWLIS. Letter in *Nature, Lond.*, **168**, 198–9 (*Aug.* 4, 1951).

Shows by X-ray diffraction that the structure of β–U is similar to but not identical with that of a U–Cr alloy containing 1·4 atomic % Cr. Unit cell dimensions are given for α–, β– and γ–U and for the U–Cr alloy. J. THEWLIS

548.736.1

9144. The crystal structure of the β phase of uranium. C. W. TUCKER, JR. *Acta Cryst.*, **4**, 425–31 (*Sept.*, 1951).

The crystal structure of the β phase of metallic uranium (stable between 660 and 760°c) has been deduced from X-ray diffraction measurements made on single crystals of the phase retained in an alloy containing 1·4 atomic % chromium and rapidly cooled from 720°c. The diffraction data and other measurements show that the unit cell of the β phase is tetragonal, with $a_0 = 10{\cdot}52$, $c_0 = 5{\cdot}57$ Å, and contains 30 atoms. Of the three possible space groups ($P4/mnm$, $P4nm$ and $P\bar{4}n2$), $P4/mnm$ appears definitely excluded, while of the remaining two, $P4nm$ appears to account adequately for the diffraction intensities. Positions of the 30 atoms in the unit cell have been deduced using the Patterson and Patterson–Harker F^2 syntheses and the Fourier electron-density synthesis. The β phase has a layer structure with the layers parallel to the a_0b_0 plane of the unit cell at $\frac{1}{4}c_0$ and $\frac{3}{4}c_0$. Midway between the layers are atoms which are linked to those in the adjacent layers but not to each other. The layers are quite closely related to the basal planes of the familiar hexagonal close-packed structure, except that atoms at the centres of certain hexagons are displaced normal to the layers to form the set of atoms found midway between the layers. A structure essentially the same as that of β uranium is being found by other investigators for the σ phase of the Fe–Cr and other systems. The low symmetry and complexity of the structure accounts for the rather hard, brittle nature of the phase. The interrelations between the α, β and γ phases of the metal are clear from the β-phase crystal structure, but the precise mechanism of the transformations has not yet been studied. A.

548.736.3

9145. Crystal structure of $NiMg_2$ and $AuMg_3$. K. SCHUBERT AND K. ANDERKO. Letter in *Naturwissenschaften*, **38** (*No.* 11) 259 (1951) *In German.*

Positions of atoms are given for $NiMg_2$, which is similar to $CuAl_2$. $AuMg_3$ is similar to $HgMg_3$.

A. R. STOKES

548.736.3

9146. The structure of the ζ phase in the silver–zinc system. I. G. EDMUNDS AND M. M. QURASHI. *Acta Cryst.*, **4**, 417–25 (*Sept.*, 1951).

The structure of a Ag–Zn ζ-phase alloy of 50 atomic % Ag has been determined from X-ray powder photographs, using a modified form of the method of steepest descents. The high-temperature (β-phase) form of the same alloy was taken as the starting point for the analysis, but, owing to the high symmetry of this structure, the residual, *R*, was found to have a stationary value so that the method of steepest descents failed at this stage. The difficulty was overcome by a systematic use of absent reflections, and the first approximation to the ζ structure thus obtained was subsequently refined by the steepest-descent method, including the use of order parameters. The ζ-phase alloy has a centro-symmetrical hexagonal unit cell containing 9 atoms; the lattice parameters for the 50 atomic % alloy are $a = 7{\cdot}6360$, $c = 2{\cdot}8197$ Å. The fractional co-ordinates are as follows: the 3 positions (0, 0, 0), ($\frac{2}{3}$, $\frac{1}{3}$, 0·250), ($\frac{1}{3}$, $\frac{2}{3}$, 0·750) occupied almost exclusively by Zn atoms; the 6 positions derived by symmetry operations from the position (0·350, 0·032, 0·750) occupied at random by the remaining atoms (about 75% Ag and 25% Zn). The space group is $C\bar{3}$. The Zn atom at the origin has an abnormally high thermal vibration parallel to the crystallographic axis. A.

548.736.3

9147. The crystal structure of boracite. T. ITO, N. MORIMOTO AND R. SADANAGA. *Acta Cryst.*, **4**, 310–16 (*July*, 1951).

The structures of high- and low-boracite have been analysed using powder and Weissenberg photographs (Mo $K\alpha$, $\lambda = 0{\cdot}71$ Å, Cu $K\alpha$, $\lambda = 1{\cdot}54$ Å). High: $a = 12{\cdot}1$ Å; 8 molecules per unit cell; T_d^5–$F\bar{4}3c$. Low: $a = 8{\cdot}54$, $b = 8{\cdot}54$, $c = 12{\cdot}07$ Å; 8 molecules per unit cell; C_{2v}^5–*Pca*. The two structures are essentially the same, both containing the same boron–oxygen network and differing only in the positions of magnesium and chlorine atoms. The network may be described as a rigid aggregate of BO_4 tetrahedra and BO_3O pyramids which, sharing every oxygen corner, extend indefinitely throughout the structure. A new concept of the α–β inversion of boracite is suggested. A.

548.736.3

9148. The structure of NiSi. K. TOMAN. *Acta Cryst.*, **4**, 462–4 (*Sept.*, 1951).

The structure of NiSi has been determined from Weissenberg and rotating-crystal photographs using Cu $K\alpha$ radiation. Dimensions of the unit cell, determined by the powder method, are: $a = 5{\cdot}62$, $b = 5{\cdot}18$, $c = 3{\cdot}34$ Å. The space group is *Pbnm*, and there are four molecules in the unit cell. The structure is a deformed NiAs arrangement. A.

548.736.4

9149. X-ray study on phase transition of lead zirconate, $PbZrO_3$. R. UEDA AND G. SHIRANE. Note in *J. Phys. Soc. Japan*, **6**, 209–10 (*May–June*, 1951).

Powder photographs taken at temps. from 20°C to 300°C show the changes in cell dimensions, especially at 220°C, the Curie point. A. R. STOKES

548.736.4

9150. Unit cell and space group of barium chlorate monohydrate. G. KARTHA. Letter in *Curr. Sci.*, **20**, 151 (*June*, 1951).

Monoclinic, $C2/c$, $a = 13{\cdot}27$, $b = 7{\cdot}80$, $c = 9{\cdot}35 \pm 2$ Å, $\beta = 41° 46'$, $Z = 4$, from morphology and oscillation and Weissenberg photographs.

A. J. C. WILSON

548.736.4

9151. The crystal structures of hydrogen cyanide, HCN. W. J. DULMAGE AND W. N. LIPSCOMB. *Acta Cryst.*, **4**, 330–4 (*July*, 1951).

The tetragonal form of hydrogen cyanide has the space group C_{4v}^9–*I4mm*. There are two molecules in the unit cell of dimensions $a = 4{\cdot}63$, $c = 4{\cdot}34$ Å. The crystal structure consists of infinite linear chains, all pointing in the same direction, with the molecules along the fourfold axes. The hydrogen-bond distance (C—H . . . N), based on the microwave C≡N distance of 1·16 Å, is 3·18 Å. The dielectric constant of the solid just below the melting-point is discussed in terms of a possible re-orientation of occasional molecules. The orthorhombic low-temperature form (below —102·8°C) has the space group C_{2v}^{20}–*Imm*. Again there are two molecules in the unit cell of dimensions $a = 4{\cdot}13$, $b = 4{\cdot}85$, $c = 4{\cdot}34$ Å. Except for a contraction and expansion of the tetragonal *a* and *b* distances respectively, the low-temperature structure is that of the high-temperature modification. A.

548.736.4

9152. A study of the unit-cell dimensions and symmetry of certain ferroelectric compounds of niobium and tantalum at room temperature. P. VOUSDEN. *Acta Cryst.*, **4**, 373–6 (*July*, 1951).

An account is given of the methods of preparation of the recently reported ferroelectric compounds $KTaO_3$, $KNbO_3$, $NaNbO_3$ and $NaTaO_3$, and of an investigation of their structure from powder photographs. At room temperature $KTaO_3$ is cubic and the other compounds orthorhombic, the distortion from the simple perovskite structure being similar to that which $BaTiO_3$ shows between −5 and 90°C. From an examination of the variation of Curie point with lattice parameter of these compounds, it is suggested that the factor primarily responsible for the ferroelectricity is the degree of homopolar bonding of the Ta, Ni or Ti ion with the O ion. A.

548.736.4

9153. On dicalcium ferrite and ternary solid solutions of the ferric calcium-alumina-oxide system. V. CIRILLI AND A. BURDESE. *Ric. Sci.*, **21**, 1185–91 (*July*, 1951) *In Italian.*

The dimensions of the unit cell are: $a = 5{\cdot}32$ Å; $b = 14{\cdot}63$ Å; $c = 5{\cdot}58$ Å. There are four molecules of 2 $CaO . Fe_2O_3$. The Vh^{28} (Imma) is the probable space group, in agreement with the one Büssem discovered for the brownmillerite. Further X-ray

research on the solid solutions 2 CaO . (Fe, Al)$_2$O$_3$ indicate that the brownmillerite and the 6 CaO . 2 Al$_2$O$_3$.Fe$_2$O$_3$ found by Swayze are to be considered as any intermediate terms of the series of solid solutions which have been studied. A.

548.736.5

9154. The crystal structure of orthorhombic hydrazonium sulphate. I. NITTA, K. SAKURAI AND Y. TOMIIE. *Acta Cryst.*, **4**, 289–93 (*July*, 1951).

Structure determined by Laue and rotating-crystal methods. The unit cell, containing four units of the chemical formula, has $a = 8{\cdot}251$, $b = 9{\cdot}159$, $c = 5{\cdot}532$ Å. The space group is D_2^4–$P2_12_12_1$. The atomic co-ordinates were determined by means of Patterson–Harker diagrams and two-dimensional Fourier syntheses. A.

548.736.5

9155. The crystal structure of iron lazulite, a synthetic mineral related to lazulite. L. KATZ AND W. N. LIPSCOMB. *Acta Cryst.*, **4**, 345–8 (*July*, 1951).

548.736.5

9156. Structure of tetragonal metaborates and their crystal chemical relationships. M. FORNASERI. *Ric. Sci.*, **21**, 1192–4 (*July*, 1951) *In Italian.*

Structural researches carried out on tetragonal metaborates teepleite and bandylite have shown that in both minerals are present tetrahedral B(OH)$_4$ groups. In the cell there are therefore no H$_2$O molecules but OH groups. New data are obtained concerning the crystal chemistry of cupric compounds. A.

548.736.5

9157. The crystal structure of ludlamite. T. ITO AND H. MORI. *Acta Cryst.*, **4**, 412–16 (*Sept.*, 1951).

The crystal structure of ludlamite, Fe$_3$(PO$_4$)$_2$. 4H$_2$O, has been restudied by means of the double Fourier-series method. In the revised structure an Fe$_3$O$_8$(H$_2$O)$_6$ group may be conceived as consisting of three octahedra of oxygen atoms and water molecules around an iron atom, joined by sharing the O–H$_2$O edges. Such groups are linked to each other in the directions of the *a* and *b* axes by phosphorus atoms situated at the centres of oxygen tetrahedra and in the direction of the *c* axis by the shared water molecules. The difference in cohesive properties of vivianite, Fe$_3$(PO$_4$)$_2$. 8H$_2$O, and ludlamite is explained in terms of their structures. A.

548.736.5

9158. The crystal structure of lanarkite, PbO . PbSO$_4$. W. P. BINNIE. Note in *Acta Cryst.*, **4**, 471–2 (*Sept.*, 1951).

548.736.6

9159. A Fourier analysis of the structure of tourmaline. T. ITO AND R. SADANAGA. *Acta Cryst.*, **4**, 385–90 (*Sept.*, 1951).

The crystal structure of tourmaline,

$$(Na, Ca)\,(Li, Al_3)Al_6(OH)_4(BO_3)_3Si_6O_{18},$$

has been revised using the Fourier-synthesis method. The structure is little different from that originally proposed and described by the present writers. A few minor changes in atomic positions have improved some of the interatomic distances as well as the co-ordinations of atoms. A comparison has been made with the structure arrived at by Donnay and Buerger, from which the present structure differs in the precise configuration of the Si$_6$O$_{18}$ group. A.

548.737

9160. Determination of absolute configuration of optical active compounds by means of X-rays. A. F. PEERDEMAN, A. J. VAN BOMMEL AND J. M. BIJVOET. *Proc. K. Ned. Acad. Wet. Ser. B*, **54**, 16–19 (*Jan.–Feb.*, 1951).

If one atom in an optically active molecule is excited by X-rays, the intensities of the *hkl* and $\overline{hkl}$ reflections need not be equal [see Abstr. 7414 (1949)]. This was confirmed by comparison of observed and calculated intensities of diffraction of ZrK_α radiation by NaRb tartrate. A. R. STOKES

548.737

9161. Determination of the absolute configuration of optically active compounds by means of X-rays. J. M. BIJVOET, A. F. PEERDEMAN AND A. J. VAN BOMMEL. *Nature, Lond.*, **168**, 271–2 (*Aug.* 18, 1951).

See preceding Abstr. Emil Fischer's convention regarding the configuration of *d*-tartaric acid is shown to be correct. A. R. STOKES

548.737

9162. Chrysene. J. KRC, JR. *Analyt. Chem.*, **23**, 932–3 (*June*, 1951).

Crystal morphology, optical properties, X-ray diffraction data and fusion data are given.

548.737

9163. The crystal structure of a pentachlorocyclohexene, C$_6$H$_5$Cl$_5$. R. A. PASTERNAK. *Acta Cryst.*, **4**, 316–19 (*July*, 1951).

548.737

9164. The crystal structure of lauric acid. V. VAND, W. M. MORLEY AND T. R. LOMER. *Acta Cryst.*, **4**, 324–9 (*July*, 1951).

Lauric acid (form *C* or α), C$_{12}$H$_{24}$O$_2$, is monoclinic with $a = 9{\cdot}524$, $b = 4{\cdot}965$, $c = 35{\cdot}39$ Å, $\beta = 129°\ 13'$. The cell contains four molecules; density observed 1·032, calculated 1·034 g.cm^{-3}. The space group is C_{2h}^5–$P2_1/a$. Fourier projections were prepared and atomic co-ordinates determined. The angle of tilt $\tau = 54°\ 52'$. A.

548.737

9165. The crystal structure of 1,2-dichloroethane at −50°C. M. E. MILBERG AND W. N. LIPSCOMB. *Acta Cryst.*, **4**, 369–73 (*July*, 1951).

Monoclinic, space group C_{2h}^5–$P2_1/c$, two molecules in unit cell, $a = 5{\cdot}04$, $b = 5{\cdot}56$, $c = 8{\cdot}00$ Å and $\beta = 109\frac{1}{2}°$. The Cl atoms lie in the general position with parameters $x = 0{\cdot}303$, $y = 0{\cdot}279$, $z = 0{\cdot}074$. The molecule is in the extended configuration with a Cl–Cl distance of 4·24 Å, and has a centre of symmetry. The CH$_2$ groups show nearly free rotation, or almost complete orientational disorder, approximately about the Cl–Cl axis. A.

548.737

9166. The crystal structure of salicylic acid. W. COCHRAN. Note in *Acta Cryst.*, **4**, 376–7 (*July* 1951).

548.737

9167. Note on the crystalline structures of the methyl cyanide-boron trihalides. S. GELLER AND O. N. SALMON. Note in *Acta Cryst.*, **4**, 379–80 (*July*, 1951)

548.737

9168. Note on the crystalline structure of trimethylamine-boron, $(H_3C)_3N–BH_3$. S. GELLER, R. E. HUGHES AND J. L. HOARD. Note in *Acta Cryst.*, **4**, 380 (*July*, 1951).

548.737

9169. Note on the structure of dimethylamine-boron trifluoride. S. GELLER AND M. E. MILBERG. Note in *Acta Cryst.*, **4**, 381 (*July*, 1951).

548.737

9170. X-ray crystallographic measurements on some compounds showing intramolecular overcrowding. E. HARNIK, F. H. HERBSTEIN AND G. M. J. SCHMIDT. Letter in *Nature, Lond.*, **168**, 158–60 (*July* 28, 1951).

Discusses molecular configurations of 3 : 4-benzphenanthrene, tetrabenznaphthalene, 3 : 4 : 5 : 6-dibenzphenanthrene, 1 : 4 : 5 : 8-tetraphenyl naphthalene, dianthrone and dixanthylene. A. R. STOKES

548.737

9171. Structures of molecular addition compounds. III. Ammonia-boron trifluoride, $H_3N–BF_3$. J. L. HOARD, S. GELLER AND W. M. CASHIN. *Acta Cryst.*, **4**, 396–8 (*Sept.*, 1951).

For Pt II, see Abstr. 2792 (1950).

548.737

9172. Structures of molecular addition compounds. IV. Trimethylamine-boron trifluoride, $(H_3C)_3N–BF_3$. S. GELLER AND J. L. HOARD. *Acta Cryst.*, **4**, 399–405 (*Sept.*, 1951).

548.737

9173. Structures of molecular addition compounds. V. Comparison of four related structures. J. L. HOARD, S. GELLER AND T. B. OWEN. *Acta Cryst.*, **4**, 405–7 (*Sept.*, 1951).

As a preliminary to presenting detailed comparisons of the structural results obtained for four related compounds of formula $H_3CH_2N–BF_3$, $H_3CCN–BF_3$, $H_3N–BF_3$ and $(H_3C)_3N–BF_3$, corrections to atomic positions arising from finite termination of Fourier series are made to the published data for the two compounds first listed. It is then shown that the structural data form a self-consistent pattern which correlates well with the limited available information on the relative stabilities of the addition compounds. The quite unstable methyl cyanide-boron trifluoride molecule contains significantly longer B–N and shorter B–F bond distances than the values characterizing the three relatively stable amine-boron trifluorides. The shortest B–N distance observed, 1·57 Å, is 0·07 Å larger than the value predicted by the Schomaker and Stevenson rule. A.

548.737

9174. The crystal structure of acetoxime. T. K. BIERLEIN AND E. C. LINGAFELTER. *Acta Cryst.*, **4**, 450–3 (*Sept.*, 1951).

548.737

9175. A direct determination of the crystal structure of the β form of trilaurin. V. VAND AND I. P. BELL. *Acta Cryst.*, **4**, 465–9 (*Sept.*, 1951).

548.737

9176. X-ray diffraction study of several branched-chain fatty acids. G. L. CLARK AND C.-C. CHU. Note in *Acta Cryst.*, **4**, 470–1 (*Sept.*, 1951).

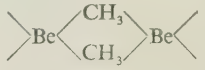
548.737

9177. The space group and optical constant of glucuronolactone. F. G. KEIHN AND A. J. KING. Note in *Acta Cryst.*, **4**, 473–4 (*Sept.*, 1951).

548.737 : 541.57

9178. The structure of dimethylberyllium. A. I. SNOW AND R. E. RUNDLE. *Acta Cryst.*, **4**, 348–52 (*July*, 1951).

Dimethylberyllium is body-centred orthorhombic, with $a_0 = 6·13$, $b_0 = 11·53$, $c_0 = 4·18$ Å, and a structure similar to SiS_2. In the



chains, the C–Be–C angle within the four-membered ring is somewhat greater than tetrahedral, and the Be–C–Be angle is only 66°. The electron-deficient Be–C bonds are 1·93 Å in length. This structure is in agreement with the rule that electron-deficient bonding results from the tendency of metals, with fewer valence electrons than low-energy orbitals, to use all their low-energy orbitals in forming bonds, even though combined with elements or groups containing no unshared pairs. A.

548.737 : 541.6

9179. Possible existence of a symmetrical O . . . H . . . O hydrogen bond in nickel dimethylglyoxime. L. E. GODYCKI, R. E. RUNDLE, R. C. VOTER AND C. V. BANKS. Letter in *J. Chem. Phys.*, **19**, 1205–6 (*Sept.*, 1951).

548.74

9180. Crystal structure of a low molecular weight protein. Electron microscopy of β-lactoglobulin crystals. I. M. DAWSON. **Crystal structure of a low molecular weight protein. Structure of dry β-lactoglobulin crystals.** D. P. RILEY. *Nature, Lond.*, **168**, 241–3 (*Aug.* 11, 1951).

Beta-lactoglobulin, which has a molecular weight of only 36 000, is examined by electron microscopy. The observed periodicities are in good agreement with those obtained from X-ray measurements and the Patterson vector-map corresponds well with the arrangement of molecules revealed by electron micrographs. J. THEWLIS

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550.341

9181. The theoretical determination of travel time. J. KILCZER. *Geofis. Pura Appl.*, **19**, 144–50 (*April–June*, 1951) *In German.*

By substituting the actual waves with plane waves and considering that any segments of the trajectories between the same wave fronts are isochronic for the vibrations, the travel-time formulae are derived without the geometrical calculations applied hitherto. A.

550.367

9182. Uranium in our planet. J. M. Lopez de Azcona. *Bol. Radiactividad*, **22**, 175–88 (1949) *In Spanish.*

The evolution of U and Th is studied; also their fractions contained in the earth's crust and the permanent radiogenic leads originated by such elements. The heat generated by the radioactive elements, chiefly by U, is considered and the conclusion reached that U is a fundamental element which has permitted the maintenance on the earth of biological conditions. A.

550.384

9183. New types of microvariations of the geomagnetic field. A. G. Kalashnikov. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 2) 255–8 (1951) *In Russian.*

550.384

9184. On the variations of the magnetic field and the rotation of the earth. N. Stoyko. *C.R. Acad. Sci., Paris*, **233**, 80–2 (*July* 2, 1951) *In French.*

A correlation is found between the fluctuations in the rate of rotation of the earth and the total magnetic force, and also the magnetic declination, at Paris. It is claimed that these results support the theory that every massive rotating body possesses a magnetic field. A. T. PRICE

550.385

9185. The normality of geomagnetic disturbance at Huancayo. S. Chapman. *Geofis. Pura Appl.*, **19**, 151–8 (*April–June*, 1951).

Evidence is adduced indicating that geomagnetic disturbance at Huancayo is normal, that is, comparable with that shown elsewhere in similar latitudes —as contrasted with the remarkable Huancayo abnormality, in the horizontal magnetic force, of the quiet-day solar and lunar daily variations, and in the S_q augmentation (solar flare effect). The normality of magnetic disturbance at Huancayo is manifested by the disturbance daily variation S_D, and by the storm-effect D_{st} and its associated changes of daily mean (D_m) and the non-cyclic variation; it is not stated whether or not the irregular part, D_i, is normal. The normality of D_{st} seems natural according to the Chapman–Ferraro theory of magnetic storms, but the normality of S_D is less easy to explain. A.

550.834.5

9186. An approximate correction method for refraction in reflection seismic prospecting. T. Krey. *Geophysics*, **16**, 468–85 (*July*, 1951).

Equations are derived and discussed to compute approximate corrections which must be applied to the results obtained by the classical methods of computing and constructing data in reflection seismic prospecting (this includes the method of construction of seismic image point and the method of seismic prospecting using zero-spread time) to correct for refraction. In addition, the influence of refraction on the determination of average velocity as obtained by applying the time-square distance-square curve (time-delta-time velocity) is analysed. A.

550.837.6

9187. An electromagnetic interpretation problem in geophysics. L. B. Slichter. *Geophysics*, **16**, 421–49 (*July*, 1951).

An interpretation problem in electromagnetic prospecting is discussed. A flat earth in which the 3 electrical properties of material vary only with depth is subjected to an alternating inducing field produced by a dipole above the surface with axis perpendicular to the surface. Observations of the horizontal or of the vertical component of the magnetic intensity at the ground's surface are supposed to be available at all distances. From these observations solutions for the 3 unknown functions are developed. When the magnetic permeability is variable, the solutions for the permeability and dielectric functions require observations at two different frequencies. The conductivity function may be found from observations at a single frequency. It is shown that the horizontal and vertical components of the magnetic field intensity are mutually dependent in the region above the ground's surface; and formulae independent of the ground's characteristics are deduced for expressing $H_\rho(\rho, z_i)$ in terms of $H_z(\rho, z_i)$ and vice-versa. Here $z = z_i \leqslant h$ denotes a plane coincident with or above and parallel to, the earth's surface. A.

550.837.6 : 538.521

Scale model experiments in electromagnetic methods of geophysical exploration. *See Abstr.* 8850

550.93

9188. On a possible source of error in the determination of the geological age of uraniferous minerals. B. Brajnikov. *C.R. Acad. Sci., Paris*, **233**, 74–5 (*July* 2, 1951) *In French.*

It is suggested that a discrepancy in the age determination of certain rocks by the ratio U^{235}/U^{238} is due to the fission of U^{235} by cosmic-ray neutrons. B. Ros

550.93 : 550.367

9189. Some geophysical consequences of natural radioactivity. J. M. Lopez de Azcona. *Bol. Radiactividad*, **23**, 135–52 (1950) *In Spanish.*

The derivation of elements from one primigenial substance is considered. The maximum and minimum number of years since the formation of the elements are discussed as well as the isotopic composition of each one of them and their variation in course of time. Calculations are given of thermic energy of radioactive origin and its variation since the formation of the elements until now. A.

550.93 : 550.367

9190. Recent work on the radioactivity of potassium and some related geophysical problems. F. Birch. *J. Geophys. Res.*, **56**, 107–26 (*March*, 1951).

The half-life now of K^{40} appears fixed at $1{\cdot}3\times10^{9}$ years, with an uncertainty of about 10%. About 12% of the disintegration forms A^{40} by *K*-capture, while 88% results in Ca^{40} by β-emission. The mean energy released per disintegration is 0·71 MeV, yielding 27×10^{-6} cal/g year of ordinary K at the present time. With these constants, the production of the A^{40} of the atmosphere, heat production by K in the earth, and measurement of age are discussed. Ample quantities of A^{40} have been produced, but release to the atmosphere involves uncertainties. A large part of the heat conducted to the surface of the earth may be generated by K decay. The existence of reasonably reliable decay constants should encourage additional efforts to obtain ages of K minerals. A.

ATMOSPHERE . METEOROLOGY 551.5

551.508 : 621.317.79

9191. Some meteorological instruments used in building research. A. W. PRATT, B. G. COLLINS, R. E. LACY AND E. W. SPINK. *Proc. Instn Elect. Engrs, Pt II*, **98**, 474–84 (*Aug.*, 1951) [*Paper No.* 1105].

For abstract see Abstr. 2195 (1951).

551.508.19 : 621.317.083.7 : 621.396.91

9192. The radar-sonde system for the measurement of upper wind and air data. F. E. JONES, J. E. N. HOOPER AND N. L ALDER. *Proc. Instn Elect. Engrs, Pt II*, **98**, 461–9, 480–4 (*Aug.*, 1951) [*Paper No.* 1095].

For abstract see Abstr. 2196 (1951).

551.508.21

9193. The Bellani spherical pyranometer or radiation integrator; the calibration of an improved model, and some suggestions for further improvements. D. L. GUNN AND D. YEO. *Quart. J. Roy. Met. Soc.*, **77**, 293–301 (*April*, 1951).

The radiation integrator of the Bellani type has been greatly improved by modern techniques and, with certain further suggested improvements, might become a generally useful instrument. Field calibration of the most recent model gives a mean thermal efficiency of about 75%, which is much higher than that of any previous model. Of the losses, 10% is invariable and irremediable, being largely due to the glass envelope, while most of the remainder is variable and due to re-radiation from the black receiver. Suggestions are made for increasing efficiency still more and reducing variability. A.

551.508.21

9194. Studies in infra-red radiation of the atmosphere. I. An instrument for the measurement of infra-red radiation during day and night. R. S. KALE. *J. Sci. Industr. Res.*, **10B**, 155–60 (*July*, 1951).

The design and construction of an instrument which can be used for measuring infra-red radiation during day as well as night are described. The new instrument and Ångström's pyrgeometer, which can be used for measuring radiation only during night, give identical values during night. The new instrument has rendered possible, for the first time, the measurement of the range of diurnal variation in the heat radiation from the atmosphere. A.

551.508.5 : 621.317.39

9195. The development of electrical anemometers. G. E. W. HARTLEY. *Proc. Instn Elect. Engrs, Pt II*, **98**, 430–7, 456–60 (*Aug.*, 1951) [*Paper No.* 1063].

For abstract see Abstr. 759 (1951).

551.508.5 : 621.317.39

9196. Wind- and gust-measuring instruments developed for a wind-power survey. H. H. ROSENBROCK AND J. R. TAGG. *Proc. Instn Elect. Engrs, Pt II*, **98**, 438–47, 456–60 (*Aug.*, 1951) [*Paper No.* 1065].

For abstract see Abstr. 760 (1951).

551.508.5 : 621.317.39

9197. An electrical method of resolving true wind velocity aboard ship. H. D. HAWKES AND J. M. LAWS. *Proc. Instn Elect. Engrs, Pt II*, **98**, 453–60 (*Aug.*, 1951) [*Paper No.* 1079].

For abstract see Abstr. 1533 (1951).

551.508.5 : 621.317.79

9198. Mean-wind-velocity instruments for use on naval craft. J. BELL AND E. M. LANGHAM. *Proc. Instn Elect. Engrs, Pt II*, **98**, 448–52, 456–60 (*Aug.*, 1951) [*Paper No.* 1103].

For abstract see Abstr. 2199 (1951).

551.508.71

9199. Thermocouple psychrometer for field measurements. F. R. BELLAIRE AND L. J. ANDERSON. *Bull. Amer. Met. Soc.*, **32**, 217–20 (*June*, 1951).

A new thermocouple psychrometer, designed to indicate true air temperature and humidity in remote locations, is described. In order to minimize maintenance, it utilizes natural ventilation, but provides adequate shielding of sensing elements against radiation. Wet and dry bulb temperature errors of less than +0·1°C are obtained in winds above 1 m.p.h. A.

551.508.71 : 621.317.79

9200. An automatic frost-point hygrometer for measurements in the upper air. A. W. BREWER AND R. H. DOBSON. *Proc. Instn Elect. Engrs, Pt II*, **98**, 470–3, 480–4 (*Aug.*, 1951) [*Paper No.* 1104].

For abstract see Abstr. 2200 (1951).

551.508.765, 551.578.11

9201. A raindrop spectrograph. E. G. BOWEN AND K. A. DAVIDSON. *Quart. J. Roy. Met. Soc.*, **77**, 445–9 (*July*, 1951).

A simple form of raindrop spectrograph is described. It is capable of giving a continuous record of the changes in the distribution of drop sizes which occur during a fall of rain. Examples are given of the spectra obtained during a variety of rain situations ranging from continuous rain to isolated showers. A.

551.510.53

9202. Photon counter measurements of solar X-rays and extreme ultraviolet light. H. FRIEDMAN, S. W. LICHTMAN AND E. T. BYRAM. *Phys. Rev.*, **83**, 1025–30 (*Sept.* 1, 1951).

Data telemetered continuously from photon counters in a V-2 rocket, which rose to 150 km at 10.00 a.m. on September 29, 1949, showed solar 8 Å X-rays above 87 km, and ultraviolet light around 1 200 Å and 1 500 Å above 70 km and 95 km, respectively. The results indicated that solar soft X-rays are important in *E*-layer ionization, that Lyman α-radiation of hydrogen penetrates well below *E*-layer, and that molecular oxygen is rapidly changed to atomic above 100 km. A.

551.510.534

9203. The observations and photochemistry of atmospheric ozone and their meteorological significance. R. A. CRAIG. *Met. Monogr. Amer. Met. Soc.*, **1** (*No.* 2) 50 *pp.* (*Sept.*, 1950).

After a brief history of significant research there is a thorough discussion and analysis of observational data with respect to latitude, season, altitude, temperature, air mass and frontal conditions and year. Variations in solar altitude, solar constant, temperature, etc., on the ozone concentration and photochemistry of the ozone layer are treated next. Then the causes of daily, seasonal and annual variation are considered. Lastly, there is a thorough bibliography and appendix containing a large amount of data

gathered in various parts of the world, and constants derived therefrom. METEOROLOGICAL ABSTRACTS

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 8854–61

551.510.535 : 550.38 : 551.54

9204. Geophysical and meteorological changes in the period January–April, 1949. W. J. G. BEYNON AND G. M. BROWN. *Nature, Lond.*, **167**, 1012–14 (*June* 23, 1951).

Attention is drawn to measurements made in Great Britain which indicate remarkable correlation between ground pressure, *E*- and *F*-layer electron density and magnetic activity during the period Jan.–April, 1949. The period concerned was one of considerable solar, magnetic and ionospheric disturbance.

W. J. G. BEYNON

551.511

9205. Energy balances in dynamic meteorology. J. VAN MIEGHEM. *Geofis. Pura Appl.*, **19**, 159–66 (*April–June*, 1951) *In French.*

Energy equations of balance are established in any type of frame moving with an arbitrary, variable velocity with respect to space and time. The equation of balance of mechanical energy can be deduced from the equations of motion of the air with respect to the moving frame. The equation of balance showing the conservation of total energy will be obtained by transposing in the moving frame, the expression of the first principle of thermodynamics given for the absolute frame. A.

551.511 : 551.513.1

9206. Physical interactions between tropical and temperate latitudes. C. H. B. PRIESTLEY. *Quart. J. Roy. Met. Soc.*, **77**, 200–14 (*April*, 1951).

The poleward transports of momentum and angular momentum, enthalpy, water vapour and total energy are studied at a number of upper-air stations in the high-pressure belt. The results confirm earlier suggestions of a mean meridional circulation across this belt; this circulation is found to contribute about one half the total poleward transport of both energy and angular momentum, and also to make a substantial contribution to the maintenance of the total kinetic energy of the atmosphere. The meridional circulation appears notably stronger in winter than in summer. Variations of eddy flux with height are examined and certain general features confirmed. The results also provide a measure of the difference between total annual precipitation and evaporation in the tropical zone. A.

551.513.1

9207. The meridional eddy flux of energy. R. M. WHITE. *Quart. J. Roy. Met. Soc.*, **77**, 188–99 (*April*, 1951).

An investigation of a large number of upper-air soundings over regions of North America shows that the eddy transport of sensible heat is poleward in the mid-latitude troposphere, reversing and becoming equatorward in the stratosphere. The eddy transport of sensible heat reaches its maximum in middle latitudes, decreasing both poleward and equatorward. The transport of sensible heat has a high seasonal variation, being much stronger in winter than in summer. There are indications that at very low latitudes the eddy sensible-heat transport is directed equatorward. The eddy transport of latent energy is described by means of the same soundings and is found to be poleward throughout middle and high latitudes with a maximum at the ground and decreasing with altitude. The principal seasonal variation in the transport of latent energy appears to be the northward shift of the mid-latitude maximum from winter to summer. This maximum is not very pronounced, the transport in both seasons being relatively constant through middle latitudes. A.

551.513.1

9208. A hemispherical study of the atmospheric angular-momentum balance. V. P. STARR AND R. M. WHITE. *Quart. J. Roy. Met. Soc.*, **77**, 215–25 (*April*, 1951).

An attempt is made to determine the meridional eddy transport of angular momentum for the northern hemisphere in the vicinity of 30°N latitude from upper-wind observations for a period of six months. Two somewhat different methods of evaluation give essentially comparable results and indicate the presence of eddy transports which are ample to compensate for frictional losses of angular momentum farther north. No indications of the presence of a mean meridional circulation of the strength and character needed to produce a sensible northward transport of angular momentum are found. A.

551.521.1 : 523.72

9209. Measurements of solar extreme ultraviolet and X-rays from rockets by means of a $CaSO_4$: Mn phosphor. R. TOUSEY, K. WATANABE AND J. D. PURCELL. *Phys. Rev.*, **83**, 792–7 (*Aug.* 15, 1951).

The presence of solar extreme ultraviolet and X-rays at high altitudes in the atmosphere was detected by means of a thermoluminescent phosphor, $CaSO_4$: Mn, which was not sensitive to wavelengths above 1 340 Å [Abstr. 8649 (1951)]. Samples of the phosphor were flown in V-2 rockets and exposed to sunlight. By means of filters of Be, LiF and CaF_2, response was measured in the wavelength bands 0–8 Å, 1 050–1 340 Å and 1 230–1 340 Å. X-rays were observed on one flight which reached 128 km, during which a sudden ionospheric disturbance occurred. Wavelengths between 1 050 and 1 340 Å were observed on all four flights and reached as low as 80–90 km. A tentative value of 0·04 microwatt/cm² was calculated for the total intensity in the solar spectrum in the range 1 050–1 240 Å, which includes the Lyman α-line of H, at an altitude level somewhere between 82 and 127 km. A similar value for the range 1 230–1 340 Å was 0·02 microwatt/cm². A comparison of the responses of the phosphor strips flown without filters and those with filters indicated that radiation between 795 and 1 050 Å reaches the region 82–127 km with an intensity well above that produced by a 6 000°K blackbody sun. A.

551.521.3

9210. Transparency of the atmosphere in the ultraviolet part of the spectrum. S. F. RODIONOV. *Izv. Akad. Nauk, SSSR, Ser. Geogr. Geofiz.*, **14** (*No.* 4) 334–58 (*July–Aug.*, 1950) *In Russian.*

A method of determining the anomalous increase in transparency of the atmosphere to ultraviolet light

from the sun, by direct readings taken with a sensitive electrophotoelement, was worked out by the author during the Elbrus Expedition (1934–35). The equipment, theory and control experiments to eliminate possibility of errors due to scattering in the instruments or refraction in the air, are described. Additional measurements made during 1936, 1937 and 1949 at high altitudes are analysed and presented. Comparison of the author's "anomalous transparency" to wavelengths of 3 100–2 900 Å (or lower) with the "Umkehr Effect" of Götz and Dobson, shows remarkable similarity. Selective effect of aerosols and ozone on oblique ultraviolet rays of sun considered. An important study based on 20 years of investigations in theoretical radiation and on observations made at stations up to 4 250 m elevation and to 5·5 km in the free air. METEOROLOGICAL ABSTRACTS

551.521.3

9211. Measurements of absorption of solar radiation by clouds. S. FRITZ AND T. H. MACDONALD. *Bull. Amer. Met. Soc.*, **32**, 205–9 (*June*, 1951).

The measurements of absorption of solar radiation in extensive cloud systems suggest an average value of about 20% absorption. This is substantially higher than an extrapolation of the theoretical computations indicates. A.

551.574.1

9212. The size of cloud droplets in layer-type cloud. A. C. BEST. *Quart. J. Roy. Met. Soc.*, 77, 241–8 (*April*, 1951).

The rate of growth of cloud droplets round a salt nucleus is examined and it is shown that, with nuclei of the size quoted in published measurements, the drop radius achieved in the period before the droplet is carried out of the cloud layer by turbulent diffusion is in reasonable accord with published measurements of the mean drop radius. It is also shown that the maximum drop radius reached when the droplet leaves the cloud owing to fall under gravity is of the same order as the largest cloud-drop measurements. The effect of temperature is considered. A.

551.574.1

9213. Drop-size distribution in cloud and fog. A. C. BEST. *Quart. J. Roy. Met. Soc.*, 77, 418–26 (*July*, 1951).

Experimental data relating to drop-size distribution in cloud and fog are examined and it is shown that in many cases the size distribution can be represented by the formula $1 - F = \exp[-(x/a)^n]$ where F is the fraction of liquid water in the air comprised by drops with diameter $< x$. The constant a increases with the liquid water content of the cloud. It is not clear what governs the value of the constant n but a reasonable mean value is about 3·3. It is shown that, if the drop-size distribution can be described by the equation, the median volume diameter is the most suitable parameter for describing the average size of the cloud particles when the value of n is not known. A.

551.574.1 : 551.578.11

9214. The production of showers by the coalescence of cloud droplets. F. H. LUDLAM. *Quart. J. Roy. Met. Soc.*, 77, 402–17 (*July*, 1951).

The growth of unusually large cloud droplets by coalescence within isolated convective clouds is examined. It is found that if their initial radii are about 20 μ or more then growth into raindrops may readily occur. Raindrop nuclei of this size may be provided by spray in maritime air masses, but there is reason to suppose that in continental air masses droplets of the required initial size are not naturally introduced into the bases of convective clouds. Therefore the coalescence mechanism of precipitation release is probably effective only in maritime air masses. A condition for the production of a shower by the coalescence mechanism is obtained and applied to predict a minimum critical cloud depth of about 1½ to 2 km. Showers may develop from clouds wholly below the 0°C isotherm if their base temperature exceeds about 8°C. A relation between the size of raindrops and the speed of the convective updraught is found. and an association is discovered between the non-fulfilment of conditions for raindrop-splitting within cloud and the absence of thunder. A.

551.576 : 551.511 : 532.59

9215. Billow clouds. R. S. SCORER. *Quart. J. Roy. Met. Soc.*, 77, 235–40 (*April*, 1951).

The difficulties of deducing a formula for the dimensions or spacing of cloudlets on the assumption that they are convection cells or unstable waves are discussed. The formula: Wavelength = $2 \cdot 6938h$, where h is the depth of the statically unstable layer, is then deduced for billow clouds of a particular type, on the assumption that they consist of parallel rows of rotating masses of air moving with the mean wind of a shearing layer and sandwiched between stable wave motions above and below. A.

551.593.5

9216. Studies on the scattering of the sun's light by the earth's atmosphere. T. SATO. *Sci. Rep. Tôkohu Univ., 5th Ser., Geophys.*, **2** (*No.* 1) 1–26 (*March*, 1950).

The author presents a detailed solution of the theoretical formula for global (whole sky) radiation, taking into consideration both primary and secondary scattering. Berlage's formula (1928) considers secondary scattering zero when the sun is at the zenith. Tables and nomograms are compiled and presented for total and partial sky radiation at various solar angles and from various portions of the sky. The results agree very well with actual observations but are in every case higher (for global radiation) than Berlage's values. Methods of evaluation of data from a Gorczynski pyranometer are described.

METEOROLOGICAL ABSTRACTS

551.593.5

9217. The coefficient of scattering of light on large particles. K. S. SHIFRIN. *Izv. Akad. Nauk, SSSR, Ser. Geogr. Geofiz.*, **14** (*No.* 1) 64–9 (*Jan.–Feb.*, 1950) *In Russian.*

Mie's formula (1908) gives a coefficient of scattering of πa^2 for particles which are large in proportion to the wavelength of the light. Investigations by the author show that part of the coefficient is determined by internal refraction and part by (external) diffraction. The total scattering should, therefore, be $2\pi a^2$. This paper develops this formula in detail.

METEOROLOGICAL ABSTRACTS

551.593.5 : 551.593.62 : 551.593.7

9218. The scattering of light by large drops of water and the polarization of the light from the rainbow. K. S. SHIFRIN. *Izv. Akad. Nauk, SSSR, Ser. Geogr. Geofiz.*, **14** (*No.* 2) 128–63 (*March–April*, 1950) *In Russian.*

The methods of geometrical optics and Fresnel's formulae are used and calculations made for multiple internal reflections up to eight in number. Polar diagrams and detailed tables are given for the intensity of the light scattered at one-degree intervals from the direction of the incident beam. In the case of the rainbow, the geometrical theory gives infinite intensity in the direction of the bow but the degree of polarization is obtained quite definitely.

METEOROLOGICAL ABSTRACTS

551.593.62

9219. A direct derivation of the equation of Airy's wave front of the rainbow. F. MORÁN. *Rev. Geofis.*, **10**, 20–3 (*Jan.–Feb.*, 1951) *In Spanish.*

A direct and, although simple and brief, a correct derivation of Airy's equation for the wave front emerging from a water drop. M. DOPORTO

551.593.9

9220. On nocturnal radiation. I. Theoretical consideration. G. YAMAMOTO. *J. Met. Soc. Japan*, 28 (*No.* 1) 1–11 (*Jan.*, 1950).

Using absorption coefficients of water vapour (Yamomoto–Onishi and Elsasser), CO_2 and O_3, incoming atmospheric radiation with clear skies was calculated and compared with observations. Calculation gave incoming radiation as: $(1 - 0{\cdot}76 \times 10^{-\cdot 353W})/T_0^4$ (W = cm precipitable water). Observation gave: $(0{\cdot}51 + 0{\cdot}066T_0^4)$ (= surface vapour pressure, mb.). METEOROLOGICAL ABSTRACTS

551.594.14

9221. New studies on the radioactivity of the atmosphere. V. F. HESS. *Arch. Met., Geophys. Bioklimatol., Ser. A*, **3** (*No.* 1–2) 56–63 (1950) *In German.*

The effect of the gamma-rays from radioactive substances in the atmosphere near New York was measured in an ionization chamber; it averaged 0·15 I (ion pairs/cm³/sec) with considerable day-to-day variations. Alpha-rays from radon and its decay products gave 0·93 I and from thoron and its decay products 0·83 I. The radon content averaged 46×10^{-18} curie/cm³. METEOROLOGICAL ABSTRACTS

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

616.073.75 : 537.531.08 : 537.542

A scintillation counter for the relative determination of X-ray intensities in radiological work. *See Abstr.* 8799

616–073.75 : 539.16.08 : 537.542

Scintillation detector for the localization of radioactive concentrations *in vivo*. *See Abstr.* 8800

PHOTOGRAPHY 77

771.5 : 537.312.5 : 548.0

9222. Absorption of light, internal photo-effect, and photographic sensitivity in silver iodide. B. BARSHCHEVSKIĬ. *J. Exp. Theor. Phys., USSR*, **20**, 862–3 (*Sept.*, 1950) *In Russian.*

Comparison of the curves of the internal photo-effect, plotted against the incident and absorbed energy, reveals that in the regions $\lambda = 313$–365 and $\lambda = 410$–430 mμ the internal effect has a selective character, particularly near the edge of the auto-absorption band at $\lambda = 420$ mμ. The photographic properties of AgI ought to be compared rather with its photoelectric properties (the selective character of the phenomena being taken into consideration) than with the absorption of light by the layers along the spectrum. F. LACHMAN

778.3

9223. On the eradication of unwanted electron tracks in electron-sensitive nuclear emulsions without loss of sensitivity. G. ALBOUY AND H. FARAGGI. Letter in *Rev. Sci. Instrum.*, **22**, 532–3 (*July*, 1951).

An improved eradication technique is described in which Ilford G5 emulsions are stored at 60°C in an atmosphere saturated with water vapour for 15–20 hours. The plates can record minimum ionization tracks after this treatment. By increasing the temperature the eradication time can be shortened still further. A. C. COATES